ECONOMICS OF HIGHER-YIELDING VARIETIES OF RICE WITH SPECIAL REFERENCE TO A SOUTH INDIAN DISTRICT ... WEST GODAVARY (ANDHRA PRADESH)

By

Shobhana Madhavan

A Thesis presented for the degree of Doctor of Philosophy

School of Oriental and African Studies

University of London

1975

ABSTRACT

The thesis is a study of some economic aspects of higher-yielding varieties of rice with special reference to small farmers in the West Godavary district of Andhra Pradesh. The introduction of higher-yielding varieties represents a major technological breakthrough in Indian agriculture. They are expected to play an important role in increasing food production. The successful cultivation of these varieties depends upon the use of non-conventional inputs like chemical fertilisers and pesticides and the adoption of improved water management practices. The ability to increase rice production by means of these varieties will depend upon the availability of these inputs on farms of all sizes. Rice cultivation in India is undertaken predominantly on small farms. Such farms face several difficulties in acquiring these inputs. Any assessment of the impact of the new varieties in increasing rice production in the country as a whole will require identification of these difficulties.

Chapter I contains brief descriptions of the new varieties and of the region studied; the term "small farm" is then defined for the purpose of the present study. Chapter II examines the role of irrigation in the cultivation of the new varieties. Chapter III deals with fertilisers; it explores the factors influencing demand at the micro-level. Chapter IV examines the nature and implications of the increased application of human labour input on farms resulting from controlled irrigation and high levels

of fertiliser use. Chapter V returns to the themes developed in the earlier chapters and presents the demand for and supply of fertilisers and facilities for control of irrigation in the form of a generalised input, namely, credit. The inferior access of small farms to institutional credit is seen as an obstacle to their effective contribution to the programme of increasing rice production. Chapter VI contains the principal conclusion of this thesis: that the potential contribution of small farms to rice production has hitherto received inadequate attention and may be considerably more significant than is at present supposed.

ACKNOWLEDGEMENTS

Any attempt to apply economic principles to problems of technical change is fraught with temptations; while struggling to come to grips with the economic dimensions of the problem at hand, one is all too readily distracted by the precision of technical details. For saving me from this fate and guiding my research with patience and understanding I wish to thank my supervisor, Mr Terence J. Byres. I would also like to express my appreciation for their kind assistance to the library staff of the School of Oriental and African Studies, the High Commission of India, and the Polytechnic of Central London, especially to Miss M. Travis of the India House Library. I am also grateful for the help and encouragement I received from my colleagues at the P.C.L. While all have contributed to this, it is nevertheless only fair to express my special appreciation to Professor Keith Alan-Smith, Mr D. Croome and Mr L. Ross for their moral support. Finally, I wish to thank Mrs J. Rebello for her expert typing of the thesis and the reprographic unit of the P.C.L. for duplication of the script.

CONTENTS

ABBREVIATIONS AND MEASUREMENTS

A In Text

AIRCRC	All-India Rural Credit Review Committee
AIRDIS	All-India Rural Debt and Investment Survey
ARCS	All-India Rural Credit Survey
FMS	Farm Management Survey
HYV	Higher-Yielding Varieties
HYVP	Higher-Yielding Varieties Programme
NSS	National Sample Survey
PEO	Programme Evaluation Organisation

B In Footnotes

ARCS	All-India Rural Credit Survey
AIRDIS	All-India Rural Debt and Investment Survey
ASI	Agricultural Situation in India
EPW	Economic and Political Weekly
FMS	Farm Management Survey
IF	Indian Farming
IJAE	Indian Journal of Agricultural Economics
RAIRCRC	Report of the All-India Rural Credit Review Committee
RBIB	Reserve Bank of India Bulletin

C Measurements

1 Measure Paddy = $2/3$ Cleaned Rice

INTRODUCTION

Measures designed to increase production of foodgrains were outlined in the Fourth Five Year Plan.[1] The new strategy is to stimulate cultivation of higher-yielding varieties of crops. Due to their inherent genetic ability to absorb high levels of fertilisers, these varieties are capable of producing yields several times higher than traditional varieties.[2] The latter tend to "lodge"[3] if fertilisers are pushed to high levels. It is this characteristic that has hitherto limited the scope for increasing crop production by means of increased use of fertilisers. There is yet another difference between the two varieties. Whereas traditional varieties are products of selection of seeds capable of adaptation to adverse environmental conditions, the new varieties perform well only under conditions of good husbandry such as controlled application of water and the use of plant protection measures.[4]

1 Government of India, Planning Commission, Fourth Five Year Plan 1969-74, New Delhi, 1970, pp 113-188.

2 The new varieties maintain high levels of yield up to levels of application of fertilisers 3 to 4 times as high as the level at which traditional varieties show a decline in yield. Potential increase in yield is of the order of 200 per cent and more.

3 "Lodging" refers to the state where the plant droops with weight of the ears of grain on account of weak straws thereby resulting in loss of yield, Ghosh,R.L.M., Ghatge,M.B. and Subramanian,V. Rice in India, Indian Council of Agricultural Research, New Delhi, 1960, pp 110-117.

4 Swaminathan,M.S. 'Scientific Implications of the Higher-Yielding Varieties Programme,' Economic and Political Weekly, IV, 1 & 2, Annual Number, Jan. 1969, p 69; Palmer,I. Science and Agricultural Production, United Nations Research Institute for Social Development, Geneva, 1972, pp 6-8.

The implementation of the Higher-Yielding Varieties Programme represents a major technological breakthrough in Indian agriculture.[1] During the 'fifties, the most important development was the extension of irrigated areas from 51 million acres (1950-51) to 70 million acres (1960-61), an increase of abour 36 per cent.[2] During the Third Plan period (1961-62 to 1965-66) agricultural development centred around the Intensive Agricultural Districts Programme. The programme aimed to maximum aggregate returns from scarce inputs like fertilisers by concentrating production effort in areas where conditions favoured a quick return to such efforts. The areas chosen were those with assured rainfall or irrigation and least subject to hazards like floods and droughts.[3] In addition, the areas selected for intensive development were those that had well developed rural institutions like cooperatives. The Intensive Agricultural Districts Programme was based on the concept of complementarity of agricultural inputs like fertilisers, water management and plant protection measures. The Higher-Yielding Varieties Programme also revolves round this

1 Minhas, B. and Srinivasan, T. 'New Agricultural Strategy-Analysis,' Yojana, January 26, 1966, pp 20-24; an earlier attempt to increase crop output by improved methods of cultivation consisted of the Japanese method of cultivation. For a description of this method see Ghosh, R.L.M., Ghatge, M.B. and Subramanian, V. Rice in India, op.cit., pp 273-277; Government of Bombay, Department of Agriculture, Japanese Method of Rice Cultivation, Bombay, 1953; Burns, W. Technological Possibilities of Agricultural Development in India, Lahore, 1944.

2 Government of India, Planning Commission, Third Five Year Plan 1961-62 to 1965-66, New Delhi, pp 36-37.

3 Fourth Five Year Plan, op.cit., pp 113-116; Brown, D. Agricultural Development in India's Districts, Harvard University Press, Cambridge, Mass. 1971, pp 8-27.

concept. Under both programmes practical use is made of the concept; recommendations are made as to levels of inputs and agronomic practices that have to be adopted in the cultivation of crops. The important difference between the two programmes lies in the varietal characteristics of crops grown. The significance of both these programmes derives from the fact that expansion of areas under cultivation is likely to be negligible. The potentially arable area in the country is estimated at approximately 432 million acres, of which nearly 85 per cent is under cultivation. The target for land reclamation is only 0.006 per cent of the total arable land.[1]

In the preceding paragraph we traced the evolution of agricultural policy, in so far as one can speak of a coherent and comprehensive agricultural policy during the period of the first four Five Year Plans. The reservation we expressed regarding the existence of an agricultural policy is because of the general view that the emphasis on agricultural development in India's economic plans is not commensurate with the size and importance of the agricultural sector. The relative neglect of this sector has been ascribed by different critics to various reasons. Michael Lipton detects an "urban-bias" in the underlying philosophy of planning in India judging by the meagre

1 Fourth Five Year Plan, op.cit., p 121. Over the first three Five Year Plan periods, the percentage increase in cultivated area showed a declining trend. The increases during the First, Second and Third Five Year plans were 15 per cent, 3.5 per cent and 2.6 per cent respectively, Bhatia, B.M. India's Food Problem and Policy since Independence, Somiya Publications Private Ltd., Bombay 1970, p 72.

allocation of public funds to rural development and the absence of suitable incentives to foster such development.[1] We are not concerned here with appraising the shortcomings, however grave these might be, of Indian economic planning, as it relates to the agricultural sector.[2] Our interest lies in the results of successive agricultural strategies, especially the most recent one, which have been designed to increase the production of foodgrains which account for nearly two-thirds of agricultural production.[3] Although foodgrain production increased over the planning period it is still inadequate in relation to the rate of growth of population and the target for self-sufficiency in food production as stated in the Fourth Five Year Plan. To achieve this target, production of foodgrains must increase at an annual rate of 5 per cent per annum.[4] Table I shows that the compound rate of growth of foodgrain output

1 Lipton,M. 'Strategy for Agriculture : Urban-Bias and Rural Planning,' in Streeten,P. and Lipton,M. Crisis of Indian Planning, Oxford University Press, London, 1968, pp 83-148. For a summary of the different versions of the argument that the Indian Five Year Plans give a low priority to agriculture see Chaudhuri,P. Aspects of India Economic Development - A Book of Readings, George, Allen and Unwin, London, 1971, pp 52-55.

2 These shortcomings have been described as "the running crisis of Indian Planning", Lipton,M. Strategy for Agriculture : Urban-Bias and Rural Planning,' op.cit., p 5.

3 By foodgrains is meant cereals like rice and wheat, and gram and pulses. Foodgrains account for 76 per cent of total cropped area in India, Government of India, Directorate of Economics and Statistics, Progress of Agriculture in India, New Delhi, 1972, p 13.

4 Fourth Five Year Plan, op.cit., p 120.

between 1952-53 and 1964-65 was only 2.50 per cent per annum.[1] The table also shows the relative contribution of area and yield to this increase. The compound rate of growth of output during the subsequent period, 1964-65 to 1970-71 was 3,5 per cent per annum.[2]

Table I All-India Compound Rates of Growth of Agricultural Output

per cent per annum

	Production	Area	Yield
Food Crops	2.50	0.98	1.51
Non-food Crops	3.99	2.30	1.66
All Crops	3.01	1.21	1.77

Source: Government of India, Directorate of Economics and Statistics, Ministry of Food and Agriculture, Growth Rates in Agriculture 1949-50 to 1964-65, Second Issue, 1968, p 21.

1 This rate of growth of foodgrain output was higher than the annual compound rate of growth of population of 2.19 during this period and marks a reversal of trend. For several decades before Independence agricultural growth had been much slower than increase of population, Growth Rates in Agriculture, op.cit., p 21.

2 Bansil, P.C. 'Production Patterns and the Green Revolution, Indian Journal of Agricultural Economics, XXVII, 4, Oct.-Dec. 1972, pp 104-117.

The target for self-sufficiency in foodgrain production is based on a projected increase in demand for foodgrains of 4.7 per cent per year.[1] This estimate is based on the projected annual increase in population of 2.5 per cent and a 3 per cent increase in per capita income,[2] assuming the income elasticity of demand to be 0.80 for both rural and urban areas combined.[3] By comparing the estimated demand for foodgrains of 129 million tonnes and the actual levels of production one can appreciate the magnitude of the production effort required to achieve self-sufficiency. Table II gives the actual production of foodgrains between 1966-67 and 1971-72.

1 By self-sufficiency is meant the provision of nutritionally adequate supplies of foodgrains to the population and the ending of concessional imports.

2 Fourth Five Year Plan, op.cit., p 35.

3 Ibid., p 63; For an analysis of the Planning Commission's estimates of total demand for foodgrains and the methodology of deriving them see Madalgi,S.S. 'Foodgrains Demand Projections : 1964-65 to 1975-76,' Reserve Bank of India Bulletin, XXI, 1, Jan. 1967, pp 21-29; see also, Madalgi,S.S. 'Foodgrain Self-sufficiency in the Fourth Plan,' Economic and Political Weekly, IV, 26, June 28, 1969, pp A71-A72. The Planning Commission's estimates are part of a succession of similar estimates. They are all made on the basis of differing assumptions regarding distribution of national income, foodgrain consumption among different expenditure classes, and expenditure elasticities of demand for rural and urban areas. Examples of these can be found in the following references : National Council of Applied Economic Research, Long Term Supply and Demand for Selected Agricultural Commodities, 1960-61 to 1975-76, New Delhi, 1962; Sukhatme,P.V. Feeding India's Growing Millions, Asia Publishing House, 1965, pp 101-102. For more recent estimates of demand for foodgrains and of individual crops see, Patel,A.S. and Vyas,V.S. 'An Estimate of Demand for Cereals and Pulses in the Coming Decade,' Indian Journal of Agricultural Economics, XXVI, 2, April-June 1971, pp 107-114.

Table II Production of Foodgrains, All-India, 1966-67 to 1971-72

million tonnes

Year	Rice	Wheat	Total Cereals	Total Foodgrains
1966-67	30.4	11.4	65.9	74.2
1967-68	37.6	16.5	83.0	95.1
1968-69	39.8	18.7	83.6	94.0
1969-70	40.4	20.1	87.8	99.5
1970-71	42.2	23.8	96.6	108.4
1971-72	42.7	26.5	93.6	104.7

Source: Government of India, Ministry of Agriculture, Department of Food, Annual Report, 1971-72, New Delhi, p 3.

The achievement of self-sufficiency in food production is imperative. The divergence between the actual and required levels of, and growth rates in food production give an idea of how much has to be done. The factors which make self-sufficiency essential are regional differences in the growth rates of production and of population[1] and adverse weather conditions,[2] which affect some regions more than others.

1 Growth Rates in Agriculture, op.cit., pp 29-35; Ray, S.K. 'Foodgrains Demand and Supply - Projection of Regional Imbalances,' Economic and Political Weekly, VI, 26, June 26, 1971, pp A59-A74. Explanations of India's food difficulties lie in the slow growth of food output in such populous states as Uttar Pradesh, West Bengal, Gujerat.

2 The drought of 1965-67 is a case in point. The drought of 1970-71 in Andhra Pradesh, Mysore and Maharashtra was responsible for the decline in the total production of foodgrains that year.

Due to its substantial share in the total production of foodgrains and in total consumption of food in the country, rice assumes a special importance in the drive for self-sufficiency by means of the new strategy. Rice accounts for 40 per cent of the production of foodgrains and 50 per cent of the production of cereals.[1] It is the staple food of three-quarters of the population. Of the total consumption of cereals, rice represents one-half compared to wheat and millets which account for one-sixth and one-third respectively.[2] Yet another reason for its importance is the trend towards higher per capita consumption; the All-India per capita consumption of rice increased by over 25 per cent between 1950 and 1960.[3] From its study of consumer expenditure, the National Sample Survey found that the quantity of cereals consumed increased with increase in the levels of expenditure.[4] The figures for the various rounds of the National Sample Survey are summarised in Table III. By consumer expenditure is meant all expenditure incurred for non-productive purposes during the reference period.

1 Government of India, Directorate of Economics and Statistics, Ministry of Food and Agriculture, Rice Economy of India, New Delhi, 1960, p 3. Rice occupies 28 per cent of the total area under foodgrains in the country, loc.cit.

2 Ibid. These proportions were confirmed by a later study, see United Nations, Food and Agricultural Organisation, The Economic Relationships between Grains and Rice, Commodity Bulletin Series, 39, Rome, 1965, p 19.

3 Ibid.

4 Government of India, Cabinet Secretariat, National Sample Survey, Tables with Notes on Consumer Expenditure, 19th Round, July 1964-June 1965, Number 192, New Delhi, 1971, pp 3-4.

Table III Quantity of Rice, Wheat and Cereals consumed per person for a period of thirty days in Urban and Rural areas in India, 15th to 19th Rounds.

Kilogrammes

	Rural			Urban		
Round	Rice	Wheat	Cereals	Rice	Wheat	Cereals
15th	7.58	2.50	17.33	5.56	3.93	12.2
16th	7.93	3.07	17.45	5.93	4.23	12.49
17th	8.75	2.63	17.50	6.14	4.09	12.46
18th	8.10	2.92	17.52	5.67	4.48	12.48
19th	8.13	2.74	16.19	5.61	4.43	11.65

Source: Government of India, Cabinet Secretariat, National Sample Survey, Tables with Notes on Consumer Expenditure, 19th Round, July 1964-June 1965, Number 192, New Delhi, 1971, pp 3-4.

The factors influencing the increase in demand are increase in per capita income, increase in population and urbanisation.[1] Increased per capita income and increased production have enabled people to eat more of superior cereals.[2] This is particularly so in areas where the calorie intake is low. Here, there is a tendency for consumers to supplement

1 Economic Relationships between Grains and Rice, op.cit., pp 34-59; Madalgi, S.S. 'Foodgrains Demand Projections, 1964-65 to 1975-76,' op.cit., pp 21-29.

2 Rice and wheat are generally regarded as "superior cereals" as opposed to maize and millets which are considered to be "inferior". Patel and Vyas predict that the demand for superior cereals will increase more than the demand for all foodgrains taken together by 1980-81, Patel, A.S. and Vyas, V.S. 'An Estimate of Demand for Cereal and Pulses in the Coming Decade,' op.cit., pp 113-114.

traditional staples with cereals because the latter account for 60 per cent of the total calorie intake and rice contributes to half of this.[1] The significance of rice also derives from the fact that due to the insufficiency of foods that provide animal protein, cereals will have to make good not only the total calorie deficiency but protein deficiency as well.[2] Where under-nutrition[3] is rampant, the need is to provide energy food and not protein _per se_. Recent research by nutrition experts has shown that in the

1 _Economic relationship between Grains and Rice_, _op.cit._, p 8.

2 Panse,V.G., Amble,V.N. and Abraham,T.P. 'A Plan for Improvement of Nutrition in India,' _Indian Journal of Agricultural Economics_, XIX, 2, April-June 1964, pp 13-40. An aspect of food consumption that is receiving increasing attention these days is the nutritional content of different foodgrains. This has implications for foodgrain production. Sukhatme worked out by means of linear programming techniques the quantities of major foodgrains required to meet the minimum nutritional target of calories and proteins. The per capita, per day availability of calories and proteins fell short of the requirements. In order to fill this gap, it is necessary to increase the production of each and every group of foodgrains. Sukhatme's estimates are generally regarded as the foundations of the policy for foodgrain production in India, see Sukhatme,P.V. 'The World's Hunger and the Future needs in Food Supplies,' _Journal of the Royal Statistical Society_, Series A, Vol. 124, Part 4, 1961, pp 463-508, Palmer,I. _Food and the New Agricultural Technology_, United Nations Research Unit for Social Development, Geneva, 1972, pp 1-18 and 37-45.

3 A distinction is made between 'mal-nutrition' and 'under-nutrition'. The latter refers to the quantitative inadequacy of the diet whereas the former refers to the deficiency of one or more nutrients in the diet. The present position with regard to nutrition in India is that one in every four persons is under-nourished and one in every two is mal-nourished. Panse,V.G., Amble,V.N. and Abraham,T.P. 'A Plan for Improvement of Nutrition in India,' _op.cit._, pp 13-40.

present state of our knowledge, there is no evidence to suggest that the quality and concentration of proteins in a cereal-pulse based diet is inferior to that of a non-cereal diet.[1] On the basis of these trends an absolute increase in the consumption of rice can be forecast for the future. This draws attention to the need to increase rice production.[2]

The linear rate of growth of production of rice for the period 1952-53 to 1964-65 was 3.64.[3] The growth of production was largely accounted for by increase in productivity rather than increase in area.

1 Sukhatme, P.V. 'Protein Strategy and Agricultural Development,' Indian Journal of Agricultural Economics, XXVII, 1, Jan.-Mar. 1972, pp 1-23. The average Indian diet includes only about 6.7 grams or 13.6% of animal protein per head, per day. This proportion is low even in comparison with the dietary of less developed countries where the proportion is about 15%, Panse, V.G., Amble, V.N. and Abraham, T.P., 'A Plan for Improvement of Nutrition in India,' op.cit., pp 13-40. The protein content of raw polished rice is 5 to 6% of the total nutritional value. The biological value of rice protein as determined both by animal experiments and studies on human metabolism has been found to be of a higher order and distinctly superior to that of wheat, Ghosh, R.L.M., Ghatge, M.B. and Subramanian, V. Rice in India, op.cit., p 393. Preliminary observations on new varieties indicate that it is possible to increase the protein content of rice without sacrificing their yield ability, see Barker, R. 'The Evolutionary Nature of the new Rice Technology,' Food Research Institute Studies in Agricultural Economics, Trade and Development, X, 2, 1972, p 126 and Houston, D.F. (Ed.) Rice Chemistry and Technology, American Association of Cereal Chemists, Inc., St. Paul, Minnesota, 1972, p 12.

2 These factors show that food shortages, despite increases in per capita production are not entirely due to population pressures and adverse climatic conditions, see United States Department of Agriculture, Economic Research Service, Economic Report No. 59, Economic Progress of Agriculture in Developing Nations, 1950-1968, pp 140-158.

3 Growth Rates in Agriculture, op.cit., p 26.

As in the case of total foodgrain production there are regional differences in the growth rate of rice production. They range from 0.78 per cent in Assam to 12.31 per cent in Punjab.[1] These regional differences reflect the conditions under which rice is cultivated[2] and the competition of crops for land area.[3] The southern states which account for 30 per cent of the country's total output had growth rates above 5 per cent while Assam, Bihar, Madhya Pradesh, Uttar Pradesh and West Bengal which account for 70 per cent of the total output had growth rates below the All-India growth rate of 3.64 per cent per annum.

Expectations of increased levels of production through the cultivation of new varieties have to be moderated by their actual performance since their introduction. Unlike the production of wheat there has not yet been a breakthrough in rice production. Wheat production doubled between

1 Growth Rates in Indian Agriculture, op.cit., p 26: the reference is to linear growth rates. The state-wise compound rates of growth in area, production and productivity are given in Appendix Table I.

2 Rice is cultivated under rain-fed conditions in the northern states like Bihar, Madhya Pradesh, Orissa and Assam; these areas are subject to flooding. In South India, rice is grown principally as an irrigated crop.

3 Notice the competing claims of rice and jute in West Bengal and among rice, cotton and groundnuts in Andhra Pradesh for land area; Ramiah,K. 'Rice Research in India,' Indian Farming, VL, 6, September 1966, p 6.

1964-65 and 1970-71 while the production of rice increased only marginally.[1] In fact, the rate of growth achieved during 1952-53 and 1964-65 was not even maintained during 1970-71.[2]

The slow growth of rice production despite the introduction of high-yielding varieties has been ascribed to various factors. According to some it is due to the genetic characteristics of the new varieties. Unlike wheat which is a more adaptable crop and lends itself to hybridisation, the new rice varieties are less sturdy and require major changes

1 In 1970-71, the new varieties of wheat constituted 36 per cent of total area under wheat in the country. In rice, however, the figure was only 15 per cent. In terms of actual absolute expansion in area, whereas wheat gained more than 11 million acres, rice gained less than 2.47 m acres. Actual area under the new varieties in 1970-71 was below the targetted area of 18.5 million acres by about 30 per cent, Bansil,P.C. 'Production Patterns and the Green Revolution,' Indian Journal of Agricultural Economics, XXVII, 4, Oct.-Dec. 1972, pp 104-117; Fourth Five Year Plan, op.cit., p 122; Anon, 'Green Revolution a Wheat Revolution,' Agricultural Situation in India, XXVII, 12, Mar. 1973, p 480; Kann,P. 'How Green is the Rice Revolution?' The Guardian, Nov. 20 1974. The differential rates of growth of rice and wheat production have attracted considerable attention and is one of the facts that inspired this study.

2 Saran,R. 'High-Yielding Varieties - Some Economic Aspects,' Agricultural Situation in India, XXVII, 5, Aug. 1972, pp 319-326. Whereas the compound rate of growth of production was 3.2 per cent per year during 1962-53 to 1964-65, it was only 1.3 per cent per year in 1964-65 and 1970-71, ibid. It is claimed in some quarters that the major component in the fall in foodgrain output during the drought years 1965-67 was the fall in rice output, Swaminathan,M.S. 'Crop Planning for Minimising Drought-Induced Fluctuations in Food Production,' Agricultural Situation in India, XXVII, 5, Aug. 1972, pp 305-313.

in agronomic practices. They are also highly susceptible to pests and diseases. Not only have high yield rates been sustained in the case of wheat but the impact of the new wheat varieties in reducing instability of yield has been greater than that of rice in areas of both high and low productivity.[1] It is for agronomists to explain why some crops fail and others succeed for varietal reasons. The task of the economist is to assess the economic viability of the new varieties. This we attempt in what follows.

The object of this thesis is to explore the economic factors determining the cultivation of Higher-Yielding Varieties of rice. This we do with a view to identifying the major constraints in maximising production. Production of rice is undertaken predominantly on small farms.[2] The constraints in maximising rice production are traced

1 Swaminathan,M.S. 'Crop Planning for Minimising Drought-Induced Fluctuations in Food Production,' op.cit., pp 305-313. One of the reasons for the success in wheat cultivation is that whereas the cultivation of rice is dispersed geographically, wheat is grown in more compact blocks. Part of the explanation could also lie in the dispersed nature of rice research. Unlike wheat which was the subject of concentrated research by central organisations, rice research was undertaken largely by state organisations, Pal,B.P. 'Some Thoughts on Rice Research,' India News, Feb. 26 1972.

2 The average size of farms in the predominantly rice-growing states like Madras and West Bengal is 6.08 and 2.76 acres respectively compared with the average size in predominantly wheat-growing states like Punjab and Uttar Pradesh where it is 16.50 and 9.1 acres respectively, Government of India, Directorate of Economics and Statistics, Ministry of Agriculture, Studies in the Economics of Farm Management, for Punjab (1956-57), p 9; Uttar Pradesh (1956-57), p 7; Madras (1956-57), p 9 and West Bengal (1956-57), p 2.

to the unequal opportunities small farms possess relative to large farms in the acquisition of inputs that have to be used in conjunction with the new varieties. The principal inputs identified are irrigation, fertilisers and credit. We hypothesise that the slow rate of growth in rice production is due to the small size of farms; and that this is because under the existing structure of socio-economic institutions, the distribution of farm inputs is closely related to the size of farm holdings. The nature of this relationship is fully explored in the different chapters of this thesis. It is further argued that the cultivation of new varieties tends to increase the demand for labour.

The above hypotheses are tested with reference to the state of Andhra Pradesh, especially the district of West Godavary. This state can be regarded as a microcosm of the rice economy of India. Among rice growing states in India it ranks sixth in regard to area under the crop and fifth in respect of production. It contributes 11 per cent of the total production of rice in India.[1] Of the total annual target of rice production in the Fourth Plan of 52 million tonnes the state has to contribute 5.72 million tonnes. Assuming that the share of the new varieties in the state is the same as that for the whole country, namely 20 per cent, then the total annual production of Higher-Yielding Varieties of rice has to be of the order of 1.14 million tonnes.[2]

1 Refer Appendix Table II.

2 Fourth Five Year Plan, op.cit., p 158.

Progress in the cultivation of Higher-Yielding Varieties of rice in Andhra Pradesh (as in the rest of India) has not been satisfactory. During 1964-65 and 1970-71, which is the period of our study, rice production declined by 7 per cent.[1] The area under rice was lower than in the years between 1952-53 and 1964-65; moreover productivity declined from the level registered in the earlier period.[2] Although the decline in production was partly due to the severe drought which occurred during the period of this study, adverse weather conditions are not the only explanation. In general, progress in the cultivation of the new varieties has been slow.[3]

The scope of our study is limited in that it is confined to analysis of the economic factors underlying the above phenomenon and attempts to explain how these factors influence the production of rice at the micro-level. We do not seek to explore the social and political implications of the cultivation of higher-yielding varieties, although these are relevant in any analysis of agricultural development. The

1 Saran,R. 'High-Yielding Varieties Cultivation - Some Economics Aspects,' op.cit., p 320; Pai,G.A. 'How Green is the Green Revolution?' in Pohekar,G.S. (Ed.) Studies in the Green Revolution, United Asia Publications, Bombay, 1970, p 47.

2 Ibid.

3 Swaminathan,M.S. 'Crop Planning for Minimising Drought-Induced Fluctuations in Food Production,' op.cit., p 308. These trends are a little disquieting when we consider that during the same period the predominantly wheat-growing states of Punjab and Haryana recorded the highest increase in rice production brought about both by increase in area and productivity. Ironically, the highest wheat yields next to these states were achieved in West Bengal a traditionally rice-growing state, Saran,R. 'High-Yielding Varieties - Some Economic Aspects,' op.cit., p 325; Bansil,P.C. 'Production Patterns and the Green Revolution,' op.cit., pp 104-117.

Higher-Yielding Varieties Programme, superimposed as it is on the existing disparities in the distribution of income in the rural areas in India, has sharpened the distinction between rich and poor farmers. Evidence of the unequal distribution of the gains from this programme is amply available.[1] Our concern is not with this. It is with the process of agricultural growth in its micro-economic aspect which has been explored only sparsely in the literature on agriculture development. Much of the treatment of the process of agricultural growth is in terms of broad aggregates.[2] Furthermore, a lot of the analysis is based on the neo-classical marginalist model.[3] This model is not strictly applicable to an under-developed economy like India or even to subsectors of that economy where market imperfections and social institut-

1 Frankel, F. India's Green Revolution - Economic Gains and Political Costs, Princeton University Press, Princeton, New Jersey, 1971; Parthasarathy, G. The Green Revolution and the Weaker Section, Thacker & Co. Ltd., Bombay, 1971; 'Disparity in Income in the Context of H.Y.V.P.,' Chowdhury, B.K., Economic and Political Weekly, V, 39, Sept. 26, 1970, pp A90-96; Bardhan, P. 'Green Revolution and Agricultural Labourers,' Economic and Political Weekly, V, 29-31, Special Number July 1970, pp 1239-46; Kellner, P. 'Bitter Harvest from the Green Revolution,' The Sunday Times, June 28, 1970, p 55.

2 For a cross-section of such analyses see, Eicher, C. and Witt, L. Agriculture in Economic Development, McGraw Hill Book Company, 1962.

3 A recent example of this is the following : Hayami, Y. and Ruttan, V.W. Agricultural Development: An International Perspective, The John Hopkins Press, Baltimore, 1971.

ions create rigidities.[1] In a country like India so diverse in its regional and institutional characteristics, it is important to look at micro-constraints in agricultural development.[2]

A vast literature has emerged since the introduction of higher-yielding varieties in India and elsewhere.[3] There exist two broad schools of thought with differing analyses of the potential contribution of these varieties to increased agricultural production. On the one hand, there are those who regard the new varieties as the solution to the problem of slow rates of growth of output. There are others who consider that the full potential of the new varieties will not be realised on account of social and economic constraints. We count ourselves among the latter group which adopts what Byres describes as the "bottleneck approach."[4] He regards as its principal shortcoming an inability to capture

1 Beckford,G.L. 'Strategies for Agricultural Development,' Food Research Institute Studies in Agricultural Economics, Trade and Development, XI, 2, 1972, pp 129-147; this article contains a good critique of the Hayami and Ruttan model; see also Griffin,K. The Green Revolution: an Economic Analysis, United Nations Research Institute for Social Development, Geneva, 1972, pp 9-10.

2 It is hoped that this study will form part of the much longed-for "detailed and concrete analysis of social and economic microcosms," Streeten,P. and Lipton,M. Crisis of Indian Planning, op.cit., p 7.

3 Articles on the new varieties have appeared in a wide range of journals, from the Christian Science Monitor to the American Economic Review!

4 Byres,T.J. 'The Dialectic of India's Green Revolution,' South Asia Review, V, 2, 1972, pp 99-116.

the qualitative changes brought about by the new varieties in the economic system. While we acknowledge this to be so, nevertheless, we are persuaded that it is necessary to identify the constraints in promoting growth of output by means of the new varieties. Once this is done we can put in perspective the impact of higher-yielding varieties of crops variously described as "a miracle" and "a revolution."[1]

1 Although there are innumerable serious studies on the impact of the new varieties in selected districts and states in India and elsewhere, (see Byres, 'The Dialectic of India's Green Revolution,' op.cit. for a list of the more important contributions), the general literature on the subject has ranged from prophecy and euphoria, (Brown, L. Seeds of Change, Praeger Publishers, London, 1970), to uncontrolled impressionism (Johnson, S. The Green Revolution, Hamish Hamilton, London, 1972), not to mention the predictions of the Cassandra of the Green Revolution! (Palmer, I. How Revolutionary is the Green Revolution? Voluntary Committee on Overseas Aid and Development, London, April 1973). For yet another instance of "rather immediate expressions of opinion," see Baretto, A. A Study of the Social and Economic Implications of the Large-scale Introduction of High-Yielding Varieties of Foodgrains - A Selection of Readings, United Nations Research Institute for Social Development, Geneva, 1971.

CHAPTER ONE

THE BACKGROUND TO THE STUDY

This chapter gives the background to the study of the economics of higher-yielding varieties of rice. It begins with a brief description of the new varieties. Section I.2 describes the general features of the agricultural economy of the state of Andhra Pradesh and the district of West Godavary. It also shows the progress in the cultivation of higher-yielding varieties of rice in the region in recent years. As the impact of tenurial characteristics of farm household and the size of farms is a crucial aspect of our study, the tenurial conditions of the region are discussed at some length in Section I.3. The chapter concludes with an examination of the criterion for defining farm sizes with a view to demarcate small farms. Such a delimitation of small farms is necessary because one of the tasks of our study is to show how such farms suffer considerable socio-economic disabilities in the adoption of the new varieties for cultivation.

I.1. The New Varieties

The varieties cultivated traditionally in India belong to the sub-species indica of oryza sativa.[1] They are products of selection of seeds adapted for adverse conditions over centuries and owing to their genetical constitution,[2] have low yields. These varieties have weak straws and show a tendency to lodge when treated with heavy doses of fertilisers. With moderate doses of fertilisers (27 to 36 lbs per acre) existing varieties can yield up to 2,600 lbs per acre of rice. In order to push yields to higher levels, the varietial picture has to change.[3]

The new varieties are entirely new plant types, especially evolved to give higher yields by absorbing high doses of fertilisers.[4]

1 Swaminathan,M.S. 'Scientific Implications of the Higher-Yielding Varieties Programme; EPW, IV, 1&2, Annual Number, Jan. 1969, pp 67-75. A World Survey indicated that there are about 10,000 rice varieties, of which 5,500 are to be found in India alone, Richharia,R.H. 'Rice Varieties in India, Varietial Improvements and Breeding Projects,' IF, XVII, 1, April 1967, pp 4-41.

2 The traditional varieties are tall plant types.

3 Ramiah,K. 'Rice Research in India,' IF, VL, 6, Sept. 1966, pp 6-7, 33, 40-41, especially p 40; Anon, 'Improved Crop Varieties and their Yields,' IF, XV, 2, May 1965, pp 35-40; Swaminathan,M.S. ' New Varieties Destroy Barriers to Yield,' IF, VII, 3, June 1967, pp 4-9.

4 The new varieties have high yields because they incorporate the spontaneous mutant Dee-gee-woo-gen, which Chinese scientists discovered some time ago. The dwarfing gene gives the new rice varieties other characteristics such as a dwarf plant habit (24 inches), stiff erect leaves facilitating maximum interception of sunlight and absence of seed dormancy which permits sowing to take place immediately after harvest. Dee-gee-woo-gen is to rice what Norin is to wheat, Swaminathan,M.S. 'Scientific Implication of the HYVP,' op.cit., pp 67-75.

They have an additional characteristic in that they are not "photo-sensitive"[1] and have a shorter growing period thereby permitting multiple-cropping.[2] Furthermore, the new varieties can, in principle, be bred for special characteristics such as grain quality, non-shedding and resistance to pests and diseases.[3] By and large, however, rice varieties in India have been bred for fertiliser responsiveness judging by the fact that the new varieties are still highly susceptible to pests and bacterial blight.[4]

1 The growth of these varieties is independent of day length, Grist, Rice, op.cit., p 13.

2 Swaminathan,M.S. 'Concept of Crop Planning,' IF, XX, 3, June 1970, p 41.

3 Breeding for grain quality started only in 1970, the aim being to evolve higher-yielding varieties with grain qualities comparable to that of traditional varieties. The quality of rice assumes special importance because much of the rice produced in India is consumed as cooked whole kernels unlike wheat which is made into flour and therefore broken grains do not cause a price discount; Govindaswami,S. and Ghosh,A.K. 'Breeding Higher-Yielding Varieties of Rice (Oryza Sativa) with Better Grain Quality,' Indian Journal of Agricultural Science,' XLII, 11, Nov. 1972, pp 993-998.

4 Progress in the breeding of rice varieties for resistance to pests and diseases has been small. In any case it is unrealistic to hope to incorporate all the pest-disease-resistance factors in any one variety. The problem of the high susceptibility of the new varieties to pests and diseases has to be looked at in the correct perspective. This is because, whereas, hitherto pests and diseases (rice tungro-virus, leaf and plant hoppers, bacterial leaf blight, etc.) were considered to be of minor importance, conditions under which the new varieties are grown (high plant population, heavy fertiliser application, etc.) provide a favourable environment for epidemics. For a full discussion of the problems of rice breeding see Shastry,S.V.S. 'Towards a Rice Revolution,' IF, XXII, 5, Aug. 1972, pp 95-112, especially pp 101-110; see also Hopper, W.D. and Freeman,W.H. 'From Unsteady Infancy to Vigorous Adolescence - Rice Development,' EPW, IV, 13, Mar. 1969, pp A17-A21.

At the start of the new strategy, seeds of the new varieties were imported.[1] Owing to their non-adaptability to Indian conditions, extensive hybridisation programmes were launched under the auspices of the Food and Agricultural Organisation and the International Rice Research Institute.[2] Taichung Native 1 (TN 1), developed in Taiwan was the first outstanding dwarf variety evolved in indica rices. At Rajendranagar and Mareteru in Andhra Pradesh this variety yielded, approximately, 6,000 lbs per acre being nearly double the yield of traditional varieties grown.[3] ADT-27 is an example of the indica-japonica variety. Although a popular variety in Andhra Pradesh, it is more extensively cultivated in Tamil Nadu and is largely responsible for the conversion of the single cropped area into a double cropped one in the Tanjavur delta.[4]

1 Shastry, S.V.S. 'Towards a Rice Revolution,' op.cit., p 96.

2 Rice research in India started as early as 1911. The Central Rice Research Institute at Cuttack was established in 1946. In 1965, the All-India Coordinated Rice Improvement Project was set up to coordinate rice research. By 1967, there were about 100 rice research stations and sub-stations all over the rice growing tracts in India, Richharia, op.cit., pp 4-13; Shastry, op.cit., pp 95-100; Randhawa, N.S. Agricultural Research in Institutes and Organisations, New Delhi, 1958, Chapter on Central Rice Research Institute, pp 95-105. Before the advent of the new varieties, the important role of improved seeds had been recognised by various Commissions and Committees. Improved seeds are different from the higher-yielding varieties of seeds in that the former are based on local germ plasma and have a longer growing period. In 1963, the National Seed Corporation was set up. In this connection, see Paper 17, 'Role of Improved Seeds in Increasing Agricultural Production' in Reserve Bank of India, Financing of Agriculture by Commercial Banks, Bombay, 1969, pp 233-234. India is now self-sufficient in seed production and the Seed Act is in force to control the quality of seeds, Government of India, Directorate of Economics and Statistics, Ministry of Agriculture, Progress of Agriculture in India, New Delhi, 1972, pp 31-34. The number of Improved Rice Varieties according to different states in India is given in Appendix Table III.

3 Chalam, G.V., 'TN-1 Promises Rice in Plenty,' IF, XV, 7, Oct. 1965, pp 34-35.

4 Malaya, M.M. 'Madras gets Phenomenal Rice Yields from ADT-27,' IF, XVI, 5, Aug. 1966, p 11.

IR-8, which is taken as a representative high-yielding variety in our study, is a cross between a Phillipine and a Taiwan variety. It is short-strawed, resists lodging and matures in 120-130 days.[1] In the National Demonstration Trials conducted in 1967 in ten locations by the Central Rice Research Institute, its average yield was found to be 3,822 lbs per acre. New strains of IR-8 have been evolved in India, the important ones being Jaya and Padma.[3] The former out-yields IR-8, matures earlier, has better grain quality, has greater stability of yield and the overall resistance to pests and diseases is greater.[4] It is claimed that a break-through in rice technology will come about only if these new varieties succeed.[5]

1 Swaminathan, M.S. 'Scientific Implications of the Higher-Yielding Varieties Programme,' op.cit., p 68.

2 Indian Council of Agricultural Research, Technical Report of the Central Rice Research Institute for the year 1967, New Delhi, p 8.

3 Shastry, S.V.S. 'Jaya and Padma - New High-Yielding Varieties of Rice,' IF, XVIII, 11, Feb. 1969, pp 5-13.
Shastry, S.V.S, 'Towards a Rice Revolution,' op.cit., p 96; later varieties developed are IET-1991 (similar to Jaya) and IET-1039 (similar to IR-8). These developments attest the evolutionary character of rice technology, see, Barker, R. 'The Evolutionary Nature of the New Rice Technology,' Food Research Institute Studies in Agricultural Economics, Trade and Development, X, 2, 1971, pp 118-130.

4 The yield potential of IR-8 must be set off against its grain quality. By grain quality is meant, appearance, taste, texture and aroma. These qualities determine consumer preference. IR-8 ranks low in consumer preference and is, in fact, classified as a coarse variety in India. Owing to this, this variety, sells at a discount, the price being 10 to 20 per cent below that of the superior types of traditional varieties, Barker, op.cit., p 125. For the classification of the rice varieties of commercial significance in India see, Government of India, Directorate of Marketing and Inspectorate, Ministry of Food and Agriculture, Handbook on Grading of Foodgrains and Oilseeds, (Marketing Series No. 185), Nagpur, 1971, pp 6-7.

5 Hindustan Standard, June 14, 1968, Fourth Five Year Plan, op.cit., p 123.

I.2 The Region

Andhra Pradesh is a large coastal state in the South-eastern part of the Indian sub-continent.[1] It is the fifth largest food producing state in the country, accounting for 7 per cent of the All-India production of foodgrains.[2] Agricultural growth rate here has been in line with the All-India growth rate. Between 1952-53 and 1964-65 the linear growth rate of production of all crops was 3.06 per cent and 3.43 per cent for Andhra Pradesh and All-India respectively. Table I.1 shows the linear growth rates of production, area and yield for all crops and rice during 1952-53 and 1964-65.

Table I.1. Linear Growth Rates, Andhra Pradesh, 1952-53 and 1964-65

All Crops			Rice		
Production	Area	Yield	Production	Area	Yield
3.06	0.27	2.72	5.15	3.19	1.56

Source: Growth Rates in Agriculture, op.cit., pp 29-34 & 44.

1 The state has an area of 106,272 acres. Net sown area constitutes 41 per cent of the total area, Government of India, Central Statistical Office, Statistical Abstract of India 1970, New Series, No. 18, 1972, pp 5 & 55-57. According to the last Census the state has a population of 43,395 thousand people. The rural population constitutes 80.65 per cent of the total, Census of India 1971, Series 1, Paper 1 of 1972, p 3.

2 It is also the largest contributor to the internal trade in rice, Government of India, Ministry of Agriculture, Directorate of Economics and Statistics, Bulletin on Food Statistics, Twenty-Second Issue, New Delhi, 1972, pp 12 & 80-81. In 1968-69 food crops occupied 78.8 per cent of the total cropped area, Government of Andhra Pradesh, Bureau of Economics and Statistics, Season and Crop Report of Andhra Pradesh for the year 1968-69, Hyderabad, p 17.

Agriculture including animal husbandry accounted for 55 per cent of the state's income and 73 per cent of the total working force in 1960-61.[1] Rice is the principal crop produced in the state and occupies 22.9 per cent of the total cropped area.[2] Among rice growing states in the country, Andhra Pradesh ranks sixth[3] in regard to area under rice and fifth in regard to production,[4] contributing 11 per cent of the total production of rice in India.[5]

The agro-climatic conditions are ideally suited for the cultivation of the rice crop. There are three distinct agro-climatic zones where rice is grown. (a) The Coastal districts of Andhra Pradesh accounting for 60 per cent of the total area, (b) the Telangana and (c) the Rayalaseema regions occupying 30 per cent and 10 per cent respectively.[6] There are two

1 National Council of Applied Economic Research, Distribution of National Income by States, New Delhi, 1965, p 96 and 115. The aggregate value of important agricultural commodities in Andhra Pradesh during 1968-69 was estimated at Rs 979 crores; foodgrains accounted for 496 crores or 50 per cent, Season and Crop Report of Andhra Pradesh for 1968-69, p 56. This is, of course, due to the importance of rice in the total composition of foodgrains, for, the total value of output per hectare is highest in the case of rice among foodgrain, see, Kumar,S. & Ahluwalia,S.S. 'Regional Growth of Crops - Rice, a Case-Study,' Agricultural Situation in India, XXIV, 5, Aug. 1969, p 427.

2 Season and Crop Report for Andhra Pradesh for 1968-69, op.cit., p 56.

3 Ibid., p 18; Andhra Pradesh has 8.8 per cent (average for 1967-68 to 1969-70) of the total area under rice in the Indian Union, Government of India, Ministry of Agriculture, Indian Agriculture in Brief, Eleventh Edition, 1971, p 80.

4 Season and Crop Report for Andhra Pradesh for 1968-69, op.cit., p 18. More recently, Andhra Pradesh ranks 2nd in production. It shared this distinction between 1968-69 and 1970-71 with Bihar and Tamil Nadu, Bulletin of Food Statistics, 22nd Edition, op.cit., p 12.

5 Bulletin on Food Statistics, op.cit., p 12.

6 Reddy,V.R. 'Rice Research and Development in the States - Andhra Pradesh,' IF, XVI, 6, Sept. 1966, p 83.

rice growing seasons, the Kharif season which is the main crop season extending from June/July to November/December and the Rabi season beginning in December/January and ending in April/May.[1] Nearly 80 per cent of the total area under rice is grown in the Kharif season.[2] Of the total cropped area 30 per cent is irrigated, 73.8 per cent of this being under rice cultivation.[3] The state benefits from both monsoons, the annual average rainfall being 38 inches for both seasons combined.[4]

Rice research in the state started as early as 1953. Of a total of 84 improved varieties, 35 were popular with the farmers until the advent of the HYVP during Kharif 1967-68.[5] Initially introduced in West Godavary, the new varieties are now cultivated in 20 districts.[6] Table I.2 shows the percentage distribution of area under some important higher-yielding varieties. In 1970-71 the area under HYV constituted 16 per cent of the total area under rice in the state.[7]

1 The peak marketing seasons for the two seasons are respectively, January/February and May/June, Season and Crop Report for Andhra Pradesh for 1968-69, op.cit., p 250.

2 Reddy,V.R., loc.cit.

3 Season and Crop Report for Andhra Pradesh for 1968-69, op.cit., p 13.

4 Statistical Abstract of India, 1970, op.cit., p 49.

5 Season and Crop Report for Andhra Pradesh for the Year 1967-68, op.cit., p 48.

6 Parthasarathy,G. & Prasad,D.S. 'Season-wise Progress of High-Yielding Varieties in Andhra Pradesh - Role of Economic Variables,' EPW, VI, 39, Sept. 25 1971, pp A117 to A122.

7 Saran,R. 'High-Yielding Varieties Cultivation - Some Economic Aspects,' op.cit., p 325. For the actual area under HYVP in the different districts see Appendix Table IV.

Table I.2 Percentage Distribution of Area under some Important High-Yielding Varieties of Rice to Total Area in the Different Districts of Andhra Pradesh

District	Variety									
	IR-8		T.N.-1		Jaya		Padma		Hamsa	
	1969-70/	1970-71	1969-70/	1970-71	1969-70/	1970-71	1969-70/	1970-71	1969/70	1970-71
Srikakulam	63.2	77.3	Nil	Nil	8.6	12.8	8.9	3.4	14.1	4.2
Wishakapatnam	68.4	74.5	Nil	0.3	2.4	2.9	Nil	0.4	29.2	6.9
East Godavary	38.6	38.9	Neg.	Neg.	2.4	7.2	0.2	0.2	0.3	2.9
West Godavary	83.7	73.5	1.2	0.5	4.3	Nil	3.2	Nil	3.6	2.6
Krishna	5.3	21.5	10.7	2.3	6.2	21.3	2.5	1.4	2.0	4.6
Guntur	28.2	-	1.0	-	0.7	-	0.6	-	2.4	-
Nellore	39.7	9.0	Nil	Nil	2.0	1.7	0.8	0.1	3.9	0.3
Chittor	21.1	22.5	1.0	0.9	2.8	1.9	1.0	1.6	3.8	2.5
Cuddapah	71.3	39.2	Nil	Nil	0.2	4.5	0.2	1.5	17.9	11.9
Kurnool	56.9	73.5	Nil	Nil	9.0	20.9	3.5	1.0	30.6	3.3
Ananthapur	13.0	14.8	2.1	0.5	0.2	0.5	0.6	0.7	29.7	16.2
Hyderabad	24.8	43.0	Nil	Nil	3.7	7.7	2.1	2.1	64.2	44.9
Medak	10.0	36.8	0.3	0.3	7.0	10.4	2.1	3.1	80.6	47.0
Mehaboobnagar	9.2	64.8	2.0	5.2	Nil	3.2	6.8	2.5	74.2	18.4
Warangal	63.4	52.7	Nil	0.1	5.4	12.4	6.2	5.2	8.0	11.2
Khamman	39.7	49.8	Nil	33.1	17.2	5.7	10.0	0.8	33.1	3.4
Nalgonda	18.8	44.1	Nil	Nil	16.4	37.2	24.8	3.3	36.3	13.9
Karimnagar	44.0	-	Nil	-	8.7	-	Nil	-	47.3	-
Nizamabad	25.5	67.8	Nil	Nil	Nil	13.8	Nil	0.4	63.3	7.7
Adilabad	47.6	60.0	47.6	Nil	Nil	Nil	Nil	Nil	20.3	21.6
Andhra Pradesh	38.1	53.4	2.2	2.4	3.9	8.7	2.6	1.6	8.4	7.1

Source: Parthasarathy, G. and Prasad, D.S., 'Season-wise Progress of High-Yielding Varieties in Andhra Pradesh,' EPW, VI, 39, Sept. 25, 1971, p A118.

Progress in the cultivation of some of the important varieties grown in Andhra Pradesh during 1967-68 and 1969-70 can be seen from Table I.3.

Table I.3. Progress in the Cultivation of Some Important High-Yield Varieties in Andhra Pradesh, Kharif and Rabi, 1967-68 to 1969-70.

(acres)

Variety	Kharif			Rabi		
	1967-68	1968-69	1969-70	1967-68	1968-69	1969-70
IR-8	28102	171659	427682	91879	197907	265350
TN-1	75054	15035	7609	72432	31555	15155
ADT-27	20842	36759	37215	17324	20815	14944
Jaya	Nil	Nil	5711	Nil	Nil	27648
Padma	Nil	Nil	3101	Nil	Nil	18235
Hamsa	Nil	Nil	21239	Nil	Nil	58376

Source: Parthasarathy,G. & Prasad,P.S. 'Season-wise Progress of High-Yielding Varieties in Andhra Pradesh,' EPW, op.cit., p A118.

Looking at the progress in the cultivation of the new varieties in terms of the proportion of farmers cultivating the new varieties, a recent survey conducted by the Institute of Agricultural Research Statistics provides us with some statistics. Those relating to IR-8 are presented in Table I.4.

Table I.4. Percentage Number of Farmers growing IR-8 during the Kharif and Rabi seasons in some Districts in Andhra Pradesh

District	Season			
	Rabi 1968-69	Kharif 1969-70	Rabi 1968-69	Kharif 1969-70
East Godavary	94	52	44	36
Krishna	51	46	36	56
Guntur	55	37	59	80
Nellore	92	64	56	52
Anantpur	57	66	63	49
Chittoor	58	61	54	53
Nizamabad	16	15	-	25
Warangal	58	89	50	59
Karimnagar	63	77	27	48

Source: Gupta, S.S., Bannerjee, A.K., Mehrotra, P.C. and Rajagopalan, M. 'A Study on the High-Yielding Varieties of Rice in Andhra Pradesh,' ASI, XXVIII, 1, April 1973, pp 17-18.

Note: The figures refer to the proportion of farmers growing IR-8 to the total number of farmers growing rice in the sample selected by the authors.

West Godavary is the principal rice growing district in Andhra Pradesh and has therefore been chosen for the study of the economic aspects of the HYVP.[1] One of the factors determining this choice is the continuity of statistical data thanks to the district being selected for the implementation of a succession of agricultural programmes and surveys. This district has also had the benefit of a large number of private researches and Government surveys. It was one of the districts selected for intensive study by the FMS and belongs to the second series of that Survey.[2] The IADP was launched in the Rabi season of 1960 in this district and has been continued ever since then.[3] Since the implementation of HYVP, the district has been subjected to intensive statistical analysis by the Agro-economic Research Centre.[4]

1 A high proportion of the total area under rice is seeded to the new varieties, especially IR-8, see Table I.2. above.

2 The First series of the FMS covered, on a sample basis, six major agricultural regions of India, namely, Madras, Uttar Pradesh, Madhya Pradesh, West Bengal, Bombay and Punjab for three years 1954-55 to 1956-57. The surveys involved 2,962 holdings and covered the major crops grown in India. Of the total number of holdings 37 per cent were studied intensely by the Cost Accounting Method, the remainder by the less costly method of Sample Surveys. The FMS for Andhra Pradesh belongs to the second series of such surveys and covers the years 1957-58 to 1959-60, see Government of India, Directorate of Economics and Statistics, <u>Agriculture in Brief</u>, 11th Issue, 1971, p 55-56.

3 All important crops are covered by the programme; the modified package scheme, the Intensive Agricultural Areas Programme was introduced in selected areas in 1963, <u>Season & Crop Reports</u> 1967-68 & 1968-69, p 47 (both reports).

4 Agro-economic Research Centre, Andhra University, <u>Preliminary Report on the Study of High-Yielding Varieties Programme (Kharif 1968-69: Phase I): Report on the High-Yielding Varieties Programme (Kharif 1968-69: Phase II): Report on the Study of High-Yielding Varieties Programme (Rabi 1968-69)</u>, Waltair, November 1968, September 1969 and December 1969 respectively. For a detailed description of these and other sources used, see Appendix II.

West Godavary is the richest district in the State. It has the highest percentage of net area irrigated to net sown area (70 per cent).[1] Area under foodgrains constitute 89.3 per cent of the total cropped area.[2] Of the total irrigated area 90 per cent is occupied by rice.[3] Agriculture is the chief occupation of the people; 80 per cent of the population live in the rural areas. Table I.5 gives the distribution of the population according to livelihood classes.[4]

Table I.5 Distribution of Population according to Category of Population of West Godavary 1957-58

Category of Population	Actual Numbers	Percentage
Agricultural Population Classes	24679	77.51
Cultivators of land (mainly owned) and their dependants.	8786	27.60
Cultivators of land (mainly unowned) and their dependants.	5917	18.58
Cultivating Labourers and their dependants.	8683	27.27
Agricultural Rent Receivers and their dependants.	1293	4.06
Non-Agricultural Population Classes	7159	22.49
Production other than Cultivation	2584	8.13
Commerce	1733	5.44
Transport	434	1.36
Other Services & Miscellaneous Occupations	2408	7.56
Grand Total	31838	100.00

Source: Studies in the Economics of Farm Management, West Godavary (Andhra Pradesh) 1957-58, op.cit., p 12.

1 Season & Crop Report 1968-69, op.cit., p 11; the percentage of irrigated area to total cropped area is also high being 75.3 per cent, ibid., p 13.

2 Ibid., p 17.

3 Studies in the Economics of Farm Management, West Godavary (Andhra Pradesh) 1959-60, op.cit., p 1.

4 According to the Census of 1961, households engaged in cultivation account for 44.6 per cent of the total number of households. In rural areas, they account for 52 per cent, Census of India 1961, Volume II, Andhra Pradesh, Part III Household Economic Tables, 1965, Table B-X, p 3.

I.3. Tenurial Characteristics of the Region

We turn now to the tenurial conditions that characterise farms in Andhra Pradesh. The Census of 1961 and the National Sample Survey in its 17th Round provide information on the tenurial characteristics of farms of different sizes.[1] According to the Census of 1961 pure tenants and mixed tenants[2] constituted 21.02 per cent of the total number of cultivators, their respective proportions being 6.28 and 14.74 per cent.[3] The analysis of the distribution of cultivated area by type of interest in land showed that pure tenants account for 3.68 per cent of the total operated area; mixed tenants account for 19.64 per cent.[4] The National Sample Survey provides data on the distribution of households and area by size-class of ownership holdings.[5] However, the data on tenancy in Andhra Pradesh here refer only to area

1 Chandra Sekhar,A. Census of India 1961, Volume II, Andhra Pradesh, Part III Household Economic Tables, Andhra Pradesh, 1965; for a detailed description of land tenures in the state see Mitra.A. Census of India 1961 Volume I, India, Part XI-A (i) Land Tenures in India 1966. The tenurial characteristics revealed by the Census have been analysed by Sharma,P.S. 'A Study of the Structural and Tenurial Aspects of the Rural Economy in the light of the Census 1961,' Indian Journal of Agricultural Economics XX,4, Oct/Dec 1965, pp 46-82. This analysis is useful because details of area under different types of interest in land are not provided in published records and Sharma has worked out estimates of area under tenancy from unpublished Census data. Though it is possible to work out these estimates from published figures (as the distribution of households is given according to farm sizes in terms of area) the class intervals are open-ended, and therefore no useful purpose is served by attempting this exercise.

2 Theoretically, all land belongs to the Government. The Census of 1961 distinguishes three types of interest in land (a) land owned or held directly from the Government, (b) land held from private persons or institutions for payment in money, kind or share and (c) partly held from the Government and partly from private persons for payment in money, kind or share. It is these categories that are referred to as ownership, pure and mixed tenancies respectively.

3 Census of India 1961, Household Economic Tables Andhra Pradesh, op.cit., p 15.

4 Sharma, op.cit., p 49.

5 Government of India, The Cabinet Secretariat, The National Sample Survey, No 144, Tables with Notes on some Aspects of Land Holdings in Rural Areas (State and All-India Estimates) 17th Round, Sept. 1961-July 1962, 1968, p 118.

leased-out. All farm sizes leased out land.[1] Estimates of land leased out are not very reliable for calculating the magnitude of tenancy on account of under-reporting by land owners. According to the Census of 1961 the percentage of leased-in area to total cultivated area in Andhra Pradesh works out to be 13.50 per cent approximately.[2] There are, however, wide regional variations. In the prosperous coastal districts tenants form a higher percentage of the total than in the other districts in Andhra Pradesh.[3]

The difficulty in estimating the magnitude of tenancy in the state in common with the rest of India can be traced to two sources. One is the design of the Census and the National Sample Surveys which makes the comparison of results difficult. Whereas the former refers to three types of interest in land, the NSS deals exclusively with the distribution of ownership of land and area leased-out in the case of individual states. The area leased-in has to be inferred from the area leased-out. In deciding the magnitude of tenancy this is not a satisfactory procedure because even according to the NSS results, there is considerable discrepancy between area leased-in and area leased-out at the All-India level. Thus according to the NSS, Seventeenth Round, whereas the actual area leased-in

1 National Sample Survey, Seventeenth Round, op.cit., p 128. No marked pattern emerges from the distribution of households leasing out land. If an arbitrary division is made between farms about 7.50 acres and those below this size it might be possible to say that the percentage of area leased-out to total area owned was lower in the case of farms above 7.50 acres than in the case of farms below this size. The percentage of households leasing out land followed a similar pattern. It must be emphasised that there are exceptions to the tendency just noted in both cases, see Table I.7. below.

2 This figure is arrived at on the assumption that of the total areas under mixed tenancy, half of it is leased-in: 13.50 = 3.68 (area under pure tenancy) + $\frac{1}{2}$ (19.64), see page 40 above.

3 Thus, according to the Census 1961 data the percentage of tenant households to total households in West and East Godavary are 12.79 and 19.36 respectively, Census 1961, Household Economic Tables, Andhra Pradesh, op.cit., pp 18 & 20.

under the various tenancies as a percentage of operated area for all farms was 10.70, the figure for leased-out area was only 4.97.[1] This brings us to the second source of difficulty, namely, under-reporting of land under tenancy. The desire to conceal tenancy on the part of land owners arises from the fear of land legislation that seeks to confer security on tenants and disallows sub-letting. There is, of course, no a priori reason for the greater reliability of figures of leased-in area, for tenants may fail to reveal the true nature of tenurial status for fear that landlords may fail to renew their lease. This is particularly likely to be so in the case of Andhra Pradesh where reports of private researchers suggest that landlords are particularly powerful.[2] Parthasarathy found tenancy situations more prevalent in the coastal regions in a study conducted in 1965-66. The distribution of households and cultivated area by type of interest in land is shown in the table below.

Table I.6. Percentage Distribution of Cultivating Households (H) and Cultivated Area (A) by type of Interest in Land in Selected Regions in Andhra Pradesh, 1965-66.

	Mixed Tenants		Pure Tenants		Total	
	H[a]	A[b]	H	A	H	A
Delta Region	29.86	22.36	19.37	10.91	49.26	33.27
Rayalaseema	39.34	10.56	7.60	2.59	46.94	13.15
Telangana	21.16	13.50	10.51	6.55	31.67	20.05

Source: Parthasarathy, G. Agricultural Development and Small Farmers: A Study of Andhra Pradesh, op.cit., p 15.

Note: a Total Number of Cultivating Households in the Region = 100
b Total Cultivated Area in the Region = 100

1 NSS, Seventeenth Round, op.cit., pp 18 & 219

2 Government of India, Planning Commission, A Study on Tenurial Conditions in the Package Districts, Delhi, 1965, 24. (Hereafter referred to as the Ladejinsky Report.)

Field enquiries conducted in the course of Parthasarthy's study revealed that between 40 and 50 per cent of the total area cultivated by small farmers were leased-in. What is more, leased-in area in the deltas formed 1.56 times the area owned under mixed tenancy in the size group 0.01 to 1.25 acres; three quarters of the area owned in the size group 1.25 to 2.0 acres; and a third of owned area in the size group 2.51 to 5.0 acres.[1] Turning to particular districts in the Delta region, Parthasarthy's study showed that in the East Godavary and West Godavary districts, tenant households constitute more than 30 per cent of cultivating households.[2] Of these, the majority of households have holdings less than one family holding.[3] Parthasarthy's findings are corroborated by another study conducted by the Department of Cooperation and Applied Economics, University of Andhra Pradesh during 1965-66.[4] This study found that as much as 80 per cent of total number of tenant households had less than one family holding. Such households accounted for 60 per cent of the total leased-in area. A significant fact thrown up by the study was that three-quarters of the total area leased-in in the Delta region was owned by non-resident owners. Only a quarter of the area in the region was owned by landlords resident in the region. Owners with more than three family holdings accounted for roughly 20 per cent of the total area leased-out by rural land owners. The picture that emerges from the last study is that lands owned by large cultivators were mostly self-cultivated.

1 Parthasarthy,G. Agricultural Development and Small Farmers, A Study of Andhra Pradesh, Vikas Publications, Delhi, 1971, pp 13-16.

2 Ibid., p 16.

3 Ibid., A family holding is defined as one capable of providing an income of Rs 1200 per annum. In the coastal region the farm size corresponding to this ranged from 1.14 in West Godavary district to 3.32 in Nellore, Ibid., pp 7 and 95.

4 Parthasarthy,G. and Suryanarayana Raju,K. 'Andhra Pradesh (Andhra Area) Tenancy (Amendment) Act, 1970 - A Critical Review,' EPW, VI, 13, Mar. 27 1971, p A47.

5 Perhaps it is not stretching the imagination to suggest that this phenomenon must lie behind the fact that the area leased-out as a percentage of total area owned is lower in the case of farms above 7.5 acres than in the case of farms below this size as seen in the NSS figures, see page 41 above.

The conclusion that emerges from the review of the available data on tenurial conditions in Andhra Pradesh is that ownership holdings account for the major proportion of cultivating households and cultivated area. This should not leave one with the impression that the large majority of farmers in the state enjoy the benefits of private proprietorship. Published figures on tenurial characteristics conceal important aspects of the agrarian structure, a structure which in Andhra Pradesh has been under-going rapid change in recent years.[1] Agrarian relations in India are the most complex in the world and its description, summed up by Thorner, applies to our state as well:

> " Nowhere in the world are agrarian relations more complex than in India. We have here state ownership as well as proprietory ownership. There are tenants below tenants and a wide variety of types of crop-sharers. As a result of decades of provincial land reform legislation, tenancies in various parts of India may be surrounded by with greater or lesser degrees of legal protection. In any case the rights of the tenant depend more on the size of his holding and his standing in the village than on his status in law. " 2

The key phrase in the quotation is "tenants below tenants and a wide variety of cropsharers." Much of the difficulty in measuring the extent of tenancy is due to the subtle nature of the phenomenon of share-cropping or crop-sharing. A brief description of this form of tenancy is necessary to highlight the problem of measurement.

1 Parthasarathy,G. Agricultural Development and Small Farmers - A Study of Andhra Pradesh, op.cit., pp 17-18. The reference here is to the emergence of a new class of entrepreneurs created by the prospect of profitable agriculture, the fear of land legislation on the part of large cultivators and the possibility of mechanisation on large farms. All three can be expected to have an impact on the status of tenants.

2 Thorner,D. 'India's Agrarian Revolution by Census Redefinition,' The Indian Economic Review, II,3, Aug. 1956, pp 1.21, especially p 20. Similar to Thorner's observation is the view that "the tenancy question is greater than the arithmetic of the All-India figures suggests," Sen,A.K. & Varghese,T.C. 'Tenancy and Resource Allocation,' Seminar, No. 81 (Farms and Food), May 1966, pp 28-33, especially p 30.

"Sharecropping tenancy is a subtle form of tenancy, the essence of which consists in the contribution of, in addition to labour, of a part of capital and often of fixed capital by the tenant, who receives in return a proportion of the produce from the landowner" - Khusro.[1] While sharecropping is an age-old agrarian custom in India, the land reforms legislation of the 'fifties which sought to abolish absentee landlords and confer security of tenure on tenants served to convert it into a clandestine arrangement between landlords and tenants. This was because, landlords in order to escape prosecution under the new legislation, designated themselves as owner-cultivators and their tenants as servants. As servants, the latter could not claim protection under the new legislation, and their status continuing to be that of sharecropper they were required to pay rents as exorbitantly high as 50 per cent of the gross produce.[2] Current sharecropping arrangements in the various states in India are similar.

Measurement of the extent of sharecropping is well nigh impossible because of the secrecy that surrounds it.[3] Published figures regarding its prevalence are likely to be gross under-estimates. The NSS, 17th Round, lists seven different types of leases in Andhra Pradesh and among them sharecropping was the most prevalent form of leasing.[4] The area leased-in constituted 10.70 per cent of the total area operated. Of this 4.09 per cent was under sharecropping tenancy.[5]

1 Khusro, A.M. An Analysis of Agricultural Land in India by Size of Holding and Tenure, Institute of Economic Growth, Delhi, 1964, (mimeograph) pp 70-71.

2 Ibid.

3 The results of the NSS in its 8th, 16th and 17th Rounds have nevertheless been employed to determine changes in the magnitude of tenancy. Comparing the figures for 1953-54 and 1961-62, Narain and Joshi detect a decline in tenancy which they ascribe to resumption of land by owners for self-cultivation. Bardhan argues that the decline is only apparent because impending legislation must have driven it underground. Sanyal also refers to the illusory nature of the decline, advancing the view that under-reporting must lie behind this trend. For the order of discussion on the subject as mentioned here, see Narain, D. & Joshi, P.C. 'Magnitude of Agricultural Tenancy,' EPW, IV, 39, Sept. 27, 1969, pp A139-142; Bardhan, P.K. 'Trends in Land Relations in India, A Note,' EPW, V, 3,4,5, (Annual Number) 1970, pp 261-266; Sanyal, S.K. 'Has there been a decline in tenancy?' EPW, VII, 19, May 6, 1972, pp 943-945.

4 NSS Tables with Notes on Some Aspects of Land Holdings in Rural Areas, 17th Round, op.cit., p 18.

5 Ibid.

Once again, we cannot accept these figures except as minimum limits, not because we are persuaded that all published figures are suspect but because there are no figures for a start. Traditionally, leases have been of an oral nature and even now, although there is provision for recording tenancy in village accounts, entries are seldom made in the relevant columns.[1] Oral lease is the most common form of lease in the Coastal districts of Andhra Pradesh.[2] Both power relations in the village and anomalies in tenancy legislation render the determination of the magnitude of tenancy, by type of lease, extremely difficult.[3] For purposes of a working assumption one has to take as a starting point the findings of some semi-official and private studies on the subject. These studies point to the ubiquitous nature of sub-letting and crop-sharing in the coastal districts of Andhra Pradesh. From a study of several villages in the West Godavary district Ladejinsky concluded that 50 per cent or more of cultivators were pure tenants and they accounted for 50 per cent of the cultivated area rather than 25 per cent which official estimates claimed they did.[4] Without putting a figure to the magnitude of share-cropping, Rao refers to its prevalence in the rice growing tracts of West Godavary.[5]

1 Parthasarathy, op.cit., p 13. Even records of rights do not contain information about oral leases, Ladejinsky, op.cit., p 20.

2 Government of India, Planning Commission, Implementation of Land Reforms - A Review by the Land Reforms Implementation Committee of the National Development Council, New Delhi, Aug. 1966, p 2.

3 By power relations we mean here the relative bargaining positions of the tenant and the landlord. Although landlords themselves suffer from a kind of insecurity engendered by impending legislation the stronger economic position they enjoy enables them to browbeat the tenant. One of the anomalies in tenancy laws is that the rights of mortgages of land are regulated by the Transfer of Property Act rather than Tenancy Laws.

4 Ladejinsky, op.cit., p 23.

5 Rao, C.H.H. 'Uncertainty, Entrepreneurship and Share-Cropping in India,' Journal of Political Economy, LXXIX, 3, May/June 1971, pp 578-595.

Given the high concentration of land ownership,[1] surplus labour on the land and the absence of non-farm employment opportunities, tenancy situations are most likely to arise.[2] The object of leasing in land by farmers who have insufficient land is to supplement their meagre holdings. The category of mixed tenancy comprises such farmers.[3] Farmers with uneconomical holdings are likely to lease their holdings to other cultivators.[4] Those possessing no land are likely to offer their services as agricultural labour to farmers who require such services.[5] Farmers who own substantial holdings may lease out land to obtain a size consistent with other existing factor endowments. The search on the part of both types of owners of land is to arrive at operational holdings that are economically viable.

The act of transferring land through leasing arrangements would lead one to expect the distribution of operational holdings to differ from that of ownership holdings. But this is not so as indicated by Table I.7. Raj[6] was the first to point out the similarity between the two distributions.

1 In Andhra Pradesh, 43 per cent of the total number of cultivating households cultivated less than an acre of land and accounted for a negligible part of the total owned area in the state. At the other end of the scale, about 2 per cent of the total number of households with individual holdings exceeding 30 acres accounted for 29 per cent of the total area, The National Sample Survey, Seventeenth Round, op.cit., p 118.

2 Dantwala,M.L. 'Small Farmers, not Small Farms,' in Khusro,A.M. Readings in Agricultural Economics, Allied Publishers, London, 1968, pp 418-420.

3 Sharma, op.cit., p 45.

4 Witness the leasing out of land by small farmers according to the NSS, see Table I.7 below.

5 In Andhra Pradesh, 6.84 per cent of the total number of households owned no land, NSS, 17th Round, op.cit., p 126.

6 Raj,K.N. 'Ownership and Distribution of Land,' Indian Economic Review, V, (N.S.) 1, April 1970, pp 1-42. Raj studied the Report on Landholding Rural Sector (NSS, 8th Round), No.74; the data relate to the period 1954-55.

The persistence of high concentration of operational holdings is ascribed by him to the fact that the ability of lease in land is conditioned by the amount of land already held by the prospective lessee and the perception of risk by the lesser.[1]

1 Using marginal analysis, Raj developed a succession of models which examine the factors that determine the direction and extent of transfer of land. He develops the argument that the options open to owners of large holdings of land are either to lease out land or to cultivate the land themselves by hiring labour. Both options are fraught with risk. If land is leased out to farmers with small holdings and therefore low income, the risk is default of rent. If land is leased out to farmers who have large holdings, then the risk is reduction in average rent. If the reduction of average rent necessary to eliminate the risk of rent default is high, land-owners will cultivate the land themselves by hiring labour, but the risk here is that labour may not be available at crucial stages in cultivation. The amount of land leased out will therefore be determined by the owners' attitude towards different kinds of risk. Raj goes on to show how these decisions are affected by different kinds of leasing arrangements. According to him crop-sharing will be preferred by land-owners to fixed rent, the greater "their aversion of the landowners to bearing the risks of production..." Contrast this with Rao's argument that the existence of crop-sharing arrangements is due to the very absence of entrepreneurial functions as in the case of rice cultivators in West Godavary, see Rao, op.cit., pp 584-588. Raj found from the empirical verification of his model that there was no clear indication whether share-cropping was prevalent in areas where production risks were high and therefore scope for entrepreneurial functions was greater or whether its prevalence was in areas where there was less scope for enterprise, Raj, op.cit., p 31. For a study of the concentration ratio based on data for High-Yielding Varieties of rice and wheat for the period 1967-68 to 1969-70 see Mukherjee, P.K. 'Concentration Ratio of Operational Holdings - Its Pattern and Variation,' EPW, V, 39, Sept. 26, 1970, pp A97-A100. Mukherjee found that the paddy villages in Andhra Pradesh had the highest average concentration ratio.

Table I.7. Percentage Distribution of Estimated Households (H) and Area (A) owned by Size-Class of Ownership Holdings; Percentage Distribution of Operational Holdings (H) and Area (A) operated by Size-Class of Operational Holdings; Percentage of Area Leased out and Area Leased in to Total Area owned by Size-Class of Ownership Holdings. Andhra Pradesh. 1961-62

Size-Class of Holding (acres)	Ownership Holdings		Operational Holdings		Percentage of area leased-out	Percentage of area leased-in[(a)]
	H	A	H	A		
1	2	3	4	5	6	7
upto 0.49	42.81	0.61	9.54	0.35	5.85	- 39.00
0.50-0.99	5.57	0.87	6.37	0.59	8.83	- 30.00
1.00-2.49	17.94	6.67	25.99	5.82	11.31	- 9.00
2.50-4.99	11.46	9.69	18.59	9.31	3.34	- 2.00
5.00-7.49	7.09	9.91	12.73	10.38	9.77	7.00
7.50-9.99	3.51	7.06	6.37	7.45	4.84	5.00
10.00-12.49	2.92	7.54	4.93	7.30	6.38	- 4.00
12.50-14.99	1.54	5.00	2.87	5.37	3.21	10.00
15.00-19.99	2.27	9.07	4.23	9.55	2.47	8.00
20.00-24.99	1.88	9.68	2.77	8.38	6.92	- 10.00
25.00-29.99	0.81	5.28	1.18	4.41	11.87	- 12.00
30.00-49.99	1.28	11.47	2.72	13.68	1.83	14.00
Above 50.00	0.92	17.15	1.72	17.41	2.66	- 1.00
	100.00	100.00	100.00	100.00	5.33	

Source: NSS, No.144, Tables with Notes on some Aspects of Land Holdings in Rural Areas (State and All-India Estimates), op.cit., Table (3.1), p 118; Table (9.1), p 162; Table (5.1), p 128; Table (7.0), p 153.

Note: (a) This refers to the difference between operational area and owned area expressed as a percentage of owned area. It is calculated from actual figures unlike Column 6 which shows the calculation made by the NSS.

The purpose of the above survey of tenurial conditions and the size distribution of landholdings was to identify the size-class of farms characteristic of different types of interest in land. On the basis of the NSS data, no definite conclusions can be arrived at except that all sizes in the category of ownership holdings leased out land. This data does not tell us anything about the size class of farms that leased in land. Logically, the difference between the area owned and area operated should indicate the magnitude of area leased in. Surprisingly, with the exception of size-classes 5.00 - 7.49, 7.50 - 7.99, 12.50 - 14.99, 15.00 - 19.99 and 30.00 - 49.99, the actual area operated fell short of the total area owned.[1] Does this mean that the difference signifies the area leased out? We do not know. Where the NSS data is particularly deficient is that it does not tell us anything about inter-farm transfers of land, i.e. the direction of land transfers between classes. Therefore, judgement of the size distribution of tenant farms cannot be based on these figures. To determine whether tenancy is peculiar to any particular size of farm, one has to turn to other sources. The Census of 1961 revealed that pure tenancy holdings are, by and large, holdings upto 5 acres in size. Field studies indicate that in all districts in Andhra Pradesh, tenant households are concentrated in households that cultivate less than one family holding.

1 See Table 1.7. Column 7. If we construe this difference as area leased-out, we notice that they bear no resemblance to Column 7, which shows the percentage of area leased-out. However, one must not forget the caveat, that, answers to the tenancy problem cannot be found in the "arithmetic" of tenancy figures. The impact of tenurial conditions on productions is examined in Chapter V.

I.4. Definition of Small Farms

The determination of the numerical strength of different size-groups of farms presupposes a precise definition of farm size. In our case this is particularly important as we wish to show how small farms constitute a substantial of rural households and how their unequal access to the new inputs has implications for rice production in the economy as a whole. Apart from the problem of increasing production, we need a firm idea regarding farm size for determining the relative merits of policies concerning land reforms and distribution of wealth.[1]

Farm size can be defined either in terms of a single input, say acreage, or in terms of output.[2] In the literature on the economic analysis of Indian Agriculture, the former definition has been customarily employed. The advantages claimed for this definition are that land is easily measured, is spatially fixed and is not subject to annual fluctuations.[3] Its use as

1 How serious the problem of small farmers is can be gathered from the special reference made to this category of farmers in the Fourth Plan (pp150-152), the creation of the Small Farmers Development Agency, special Reserve Bank of India directives to cooperatives societies to provide credit to such farmers and finally the institution of special programmes for the weaker sections of the population. Planning Commission, Small Farmers Development Agency - Outline of a Programme of Action, text of an address by Venkatappiah,B. to the Twenty-ninth conference of the Indian Society of Agricultural Economics held in Waltair on Dec. 30, 1969. Anon, 'Small Farmers and the Reserve Bank of India,' ASI, XXVI, 4 July 1971, p 202. Anon, 'Agricultural Credit Reorganised,' ASI, XXVI, 11 Feb. 1972, p 797. Estimates Committee, 36th Report, Ministry of Agriculture, Special Programmes for Weaker Sections and Unemployment, New Delhi, April 1973; Anon, 'Plan Programmes to benefit Small Farmers,' ASI, XXV, 2 May 1970, pp 172-173.

2 Khusro,A.M. 'Returns to Scale in Indian Agriculture,' Readings in Agricultural Development. Edited by Khusro,A.M. Allied Publishers, London, 1968, pp 123-159.

3 Ibid., see also, Vyas,V.S., Tyabi,D.S. & Misra,V.N. 'New Agricultural Strategy and Small Farms,' EPW, IV, 13, March 29, 1969, pp A49-A53.

a measure of size is justified when we are dealing with a homogenous region.[1] Furthermore, land accounts for 70 per cent to 90 per cent of the value of fixed farm capital and more than 80 per cent of net earnings is attributed to land.[2] Also in a situation of transition to intensive agriculture the size of holding determines the intensity of use of other inputs.[3]

Acreage as a measure of farm size has not found acceptance in all quarters and attempts have been made to translate farm size into a dynamic concept by introducing the notion of "economic holding".[4] An economic holding is one which under existing local conditions and techniques of production affords the cultivator a reasonable standard of living. It is also one which offers full employment to a family of normal size and a pair of bullocks. The definition resembles broadly that of the Agrarian Reforms Committee.[5] The definition of economic holding is part of the evolution of national policy on land reforms as stated in the First

1 The regions covered by the FMS are homogeneous ones. Even so differences in fertility of land within regions have been taken into account by classifying farms according to whether they are fully or partially irrigated or unirrigated.

2 Radhakrishna,D. 'Shares of Fixed Factors in Net Earnings from Agriculture in West Godavary-Andhra Pradesh,' Artha Vigyan, IV, 1, March 1 1962, pp 93-94.

3 Rao,C.H.H. 'Optimum Farm and Optimum Firm - A Comment,' Economic Weekly, XIV, 44 & 45, Nov. 10 1962, pp 1733-1736.

4 Krishna,R. 'The Optimum Farm and the Optimum Firm - I,' Economic Weekly, XIV,40, Oct. 6 1962, pp 1577-1581; also Krishna,R. 'The Optimum Farm and Optimum Firm - II,' Economic Weekly, XIV,41, Oct. 13 1962, pp 1629-1633. One of the alternative criteria suggested by the author is based on the value added by farms; see also Ramesh,D. 'Measurement of Size of Farm and Efficiency - Some Alternative Approaches,' IJAE, XXIII,1, Jan. - Mar. 1968, pp 65-66.

5 All-India Congress Committee, Report of the Agrarian Reforms Committee, New Delhi, 1951 (Second Edition), p 8.

Five Year Plan. The need for a definition arises both for the purpose of devising policies to eliminate uneconomic farms and for prescribing ceilings on land holdings.[1]

Since the publication of Farm Management Surveys for the various states, the data they provide have been used to define economic holdings. Mehra[2] defines an economic holding as one where the farm income is sufficient to meet consumption expenditure of the family engaged in agriculture and the material costs of production.[3] By far the best attempt at refining the concept of economic holding was made by Khusro in his analysis of agricultural land in India in relation to size of holdings and land tenure.[4]

1 For a summary of national policy on land reform that is relevant to the delimitation of farm size see, Government of India, Ministry of Agriculture, Department of Agriculture, Ceiling on Land Holdings, New Delhi, 1972, Chapter I, pp 1-9; Government of India, Planning Commission, First Five Year Plan, New Delhi, 1960, pp 189-193; Reports of the Committees of the Panel on Land Reforms, New Delhi, 1958, pp 100-103. For the most recent attempts at fixing land ceilings and the usual scuttling of land reforms see, Anon, 'Land Ceiling Talked Out,' EPW, VII,20, May 13, 1972, p 963; Anon, '18 acres is too high,' EPW, VI,19, May 6, 1972, p 908.

2 Mehra,D.S. 'Economic Holding Concept and Measurement,' EPW, IV,38, Sept. 1969, pp 1523-1529.

3 In so far as all of the income may not be derived from crop production, this definition leaves the source of income indefinite.

4 Khusro,A.M. An Analysis of Agricultural Land in India, by Size of Holding and Tenure, op.cit., see also Khusro,A.M. 'Farm Size and Land Tenure in India,' Indian Economic Review, IV,2, (New Series), Oct. 1969, pp 123-145.

Khusro develops the concept of minimum size of holdings. It is a size which fulfils the three following norms: the minimum plough unit, the minimum work unit and the minimum income unit.[1] The units here relate to size of farms which in the first case gives adequate employment to a pair of bullocks; in the second case it provides sufficient employment to family labour and in the third case provides an income sufficient to maintain the farm family at a reasonable standard of living. The minimum size of farm defined by all these three criteria relates to average crop and soil conditions and techniques of production as they existed in the mid-fifties. The minimum size of farm so defined in the case of Andhra Pradesh and All-India was calculated by Khusro on the basis of Farm Management data and this is presented in the Table below:

Table I.8. Minimum Size of Holding according to Plough Unit, Work Unit and Income Unit for Andhra Pradesh and All-India, in the mid-fifties.

(in acres)

Nature of Unit	Andhra Pradesh	All-India
Plough Unit	10 - 15	7.5
Work Unit	5 - 7.5	7.5
Income Unit	10	15

Source: Khusro, A.M. <u>An Analysis of Agircultural Land in India by Size of Holding and Land Tenure</u>, <u>op.cit.</u>, pp 22,32 & 38.

1 Khusro, A.M. <u>An Analysis of Agricultural Land in India by Size of Holding and Land Tenure</u>, <u>op.cit.</u>, pp 15-39.

If a certain size fails to fulfil these three criteria then it can be regarded as being inefficient in the sense of not producing at the minimum point on the long run average cost curve. On the basis of the evidence in the Farm Management data, Khusro regards a farm of five acres as the dividing line between efficient and inefficient farms.[1] Khusro then goes on to elaborate on the tenurial aspects of farm size. We shall have occasion to expand on this in connection with our discussion of tenurial disincentives faced by small farms.[2] In passing however, it is worth noting that Khusro for the first time makes extensive use of Farm Management data to arrive at a rigorous definition of farm size and by helping to tidy up our notions regarding farm size and tenurial characteristics, provides a frame-work for introducing dynamic considerations in the definition of minimum size of farms. He refers to these himself; they are general economic development, changes in consumption on farms and changes in techniques of production.[3]

Significant as attempts like those of Khusro have been in developing the notion of economic holding, the analysis of farm efficiency in Indian agriculture has revolved around the static measure of farm size. This measure has been used to highlight "an aspect of Indian agriculture", namely, the inverse relationship between farm size and productivity and the direct relationship between farm size and farm business income. These relationships have been explained in many ways.[4]

1 Khusro, A.M. An Analysis of Agricultural Land in India by Size of Holding and Land Tenure, op.cit., p 46.

2 Refer Chapter V.

3 Ibid., pp 39-45.

4 For a summary of these explanations see Bhagawati, J.N. & Chakravarty, S. 'Contributions to Indian Economic Analysis,' American Economic Review, LIX, 4, Part II, Sept. 1969, pp 2-73 especially pp 41-42.

Sen explains the inverse relationship in terms of the co-existence of small farms based on family labour and large farms which depend upon hired labour.[1] The higher labour input per acre on small farms is due to the liberal application of family labour for Sen assumes the opportunity cost of family labour to be zero. He contrasts this with large farms where the hired labour input is applied only to the point where the marginal product equals the market wage rate.[2] A similar reasoning is presented by Mazumdar who argues that the supply price of labour on large farms is higher than the ruling wage rate and therefore, per acre, labour input on large farms is smaller than that on small farms where the supply price of labour is lower.[3] Conceptually, both Sen's and Mazumdar's arguments run into difficulties, the first by his assumption that family labour cannot find alternative employment, the second in assuming that the production functions of all farms are similar.[4] Empirically, however, Mazumdar's arguments are more tenable than Sen's. Mazumdar bases his argument on the observation

1 Sen,A.K. 'An Aspect of Indian Agriculture,' The Economic Weekly, XIV, 4,5 & 6, Annual Number, Feb. 1962, p 243-246; Sen, A. K. ' Size of Holding and Productivity,' The Economic Weekly, XVI, 5,6 & 7 (Annual Number) February 1964, p 323-326.

2 We can find a parallel here between Sen's explanation and Chaynov's theory of the peasant economy. According to Chaynov, the intensity of effort is determined by the subsistence needs and the subjective distaste for manual labour. As long as the needs of the family are not met, labour will be applied even when there is decreasing returns to the labour input; Chaynov,A.V. The Theory of Peasant Economy, Edited by Thorner,D., Kerblay,B. and Smith,R.E.F., The American Economic Translation Series, 1966, pp 70-87

3 Mazumdar,D. 'On the Economics of the Relative Efficiency of Small Farmers,' The Economic Weekly, Special Number, July 1963, p 1259-1263. Mazumdar,D. 'Size of Farm and Producticity - A Problem of Indian Peasant Agriculture,' Economica, N.S. XXII, 126, May 1965, p 161-173, especially p 166.

4 For an elaboration of these difficulties, see Bhagwati,J.N. & Chakravarty,S. 'Contribution to Indian Economic Analysis,' op.cit., p 41.

that all farms, large and small, hire labour so that the inverse relationship between farm size and productivity is not determined by type of farming as suggested by Sen.[1]

The dust of the controversy over farm size and productivity has still to settle. Recently, Rudhra put the cat among the pigeons yet again by his re-examination of labour intensity on small and large farms.[2] According to him, the marginalist model which explains the inverse relationship in terms of the composition of labour on farms (hired and family labour) as used by Sen and Mazumdar is inapplicable. Nevertheless, the conflicting explanations of the inverse relationship between farm size and yield per acre have considerable analytical usefulness. Explanations of returns to scale in Indian agriculture have been based on this phenomenon.[3] The ramifications of this relationship have also been used to beat the protagonists of disguised employment with.[4]

1 Majumdar, D. 'On the Relative Efficiency of Small Farmers,' op.cit., p 1259; A corollary of Mazumdar's argument is that "(so) long as any hired labour is used, the marginal supply price to the farm is given by the ruling wage rate and consequently the input of labour would be carried to the same point in the farms of various sizes, so long as the production functions are the same," ibid. The Farm Management Surveys have shown conclusively that all farms hire labour, a fact that Sen failed to see as shown by his reaction to Mazumdar's criticisms of his article of 1962.

2 Rudhra, A. & Bandopadhya, B. 'Marginalist Explanation for more Intense Labour Input on Smaller Farms - Empirical Verification,' EPW, VIII, 22, June 2, 1973; for his earlier attempt at refuting the Sen hypothesis see, Rudhra, A. 'More on Returns to Scale in Indian Agriculture,' EPW, III, 43, Oct. 1968, pp A33-A38.

3 Khusro, A.M. 'Returns to Scale in Indian Agriculture,' in Readings in Agricultural Development, op.cit., p 122-159; Rao, C.H.H. 'Alternative Explanations of the Inverse Relationship between Farm Size and Output per acre,' The Indian Economic Review, I, (New Series), Oct. 1966, pp 1-12; Rao, A.P. 'Size of Holding and Productivity,' EPW, II, 44, Nov. 11 1967, pp 1989-91; Saini, G.R. 'Farm Size, and Productivity and Returns to Scale,' EPW, IV, 26, June 28, 1969, pp A119-A121; Bardhan, P.K. 'Size, Productivity, and Returns to Scale: An Analysis of Farm-Level Data in Indian Agriculture,' Journal of Political Economy, LXXXI, 6, Nov. Dec. pp 1370-1386.

4 The use of hired labour on all sizes of farms has been proof per se that disguised employment does not exist, see Paglin, M. 'Surplus Agricultural Labour and Development - Facts and Theories,' American Economic Review, Vol. IV, 4, Sept. 1965, pp 815-134.

The inverse relationship between farm size and productivity has far reaching implications in the context of technological change as embodied in HYV. It forms the basis of our analysis of the production potential of small farms.[1] It is in this context that we require a definition of such farms. The practice hitherto has been to equate small farms with family farms and large farms with those employing hired labour.[2] The criterion we adopt for the definition of small farms is a rough and ready one.[3] A small farm is an operational holding cultivating around 5 acres of land. An operational holding is defined as the area under crops and current fallow in a given agricultural season irrespective of ownership.[4] The use of an empirical rather than a statistical or analytical criterion can be justified on two counts. Firstly, much of the data available regarding the size

1 The implications of the inverse relationship between farm size and productivity for employment of labour on farms of different sizes is discussed in Chapter IV.

2 The division between farms based on family labour and those based on hired labour underlies the concept of dualism in Indian agriculture, Sen,A.K. 'Peasants and Dualism with or without Labour Surplus,' Journal of Political Economy, LXXIV, 5, Oct. 1966, pp 425-450; Kumar,D. 'Technical Change and Dualism within Agriculture in India,' Journal of Development Studies, VII, 1, Oct. 1970, pp 50-59. Without going into the explanations of production relations on capitalistic farms Mabro depicts large farms as capitalistic farms - a true case of fools rushing in where angels fear to tread if ever there was one (!), Mabro,R. 'Employment and Wages in Dual Agriculture,' Oxford Economic Papers, XXIII, 3, 1971, pp 402-405.

3 Throughout our study, small farms and small farmers are used synonymously.

4 The Farm Management Surveys define an operational holding in this manner, see, Government of India, Ministry of Food and Agriculture, Directorate of Economics and Statistics, Studies in the Economics of Farm Management, West Godavary (Andhra Pradesh) 1959-60, New Delhi, 1968, p 12.

distribution of farms is based on this criterion of definition.[1] Secondly because we are dealing with farms located in a homogeneous geographical region no great harm is done to our analysis by so simple a measure.[2] According to our definition, therefore, small farmers in the district of West Godavary constitute roughly 61 per cent of the total number of operational holdings and 15 per cent of the total area under rice cultivation. The total number of holdings, operated area and average size of farms according to size-class of farms are given in Table I.9.

Table I.9. Number of Holdings, Operated Area, Average Size of Holdings according to Farm-Size Groups, West Godavary, 1959-60.

Farm Size (acres)	No. of Holdings	Per cent to total	Total Area Operated (acres)	Per cent to total	Average Size of Holding (acres)
1	2	3	4	5	6
0.01-1.25	19	27.53	13.89	2.89	0.73
1.26-2.50	11	15.94	19.88	4.14	1.81
2.51-5.00	12	17.39	40.08	8.35	3.34
5.01-7.50	8	11.59	51.80	10.80	6.48
7.51-10.00	4	5.80	36.54	7.61	9.14
10.01-15.00	6	8.70	79.84	16.64	13.31
15.01-20.00	2	2.90	34.05	7.10	17.03
Above 20.00	7	10.15	203.77	42.47	29.11
All Sizes	69	100.00	479.85	100.00	6.95

Source: Studies in the Economics of Farm Management, West Godavary, (Andhra Pradesh), op.cit., p 13.

1 There is no uniformity in the size-classification of farms either in official documents starting with the Census, much less in private researches. There is no uniformity even in the various FMS. Very often the determination of the arithmetic mean in particular studies is made impossible because of open class-intervals. For problems involved in the identification of small farms, see Madalgi,S.S. 'Small Farmers: Problems of Identification,' EPW, IV,13, Mar. 1969, pp A37-A40; see also 'Small Farmers in India, and their Problems,' by the same author in Pohekar,G.S. Studies in Green Revolution, op.cit., pp 6-12.

2 The Fourth Five Year Plan, defines small farms in a similar way, op.cit., pp 538-539.

Summary

The analysis of the previous sections can be summarised as follows: the new varieties have a genetic capacity to respond to high levels of fertiliser in terms of yield per acre. The high yield potential can only be realised by control of timing and level of water application. IR-8 is the representative higher-yielding variety of rice chosen for the purpose of this study. The region selected to test the different hypotheses is the district of West Godavary in Andhra Pradesh. In 1970-71, higher-yielding varieties of rice constituted 16 per cent of the total area under rice in the state. The tenurial status of farms of different sizes has implications for incentives to grow the new varieties and the ability to bear risks. Accordingly, we examined the system of land tenure in Andhra Pradesh and found crop-sharing to be prevalent in the state, especially in West Godavary. As the aim of our study is to show that small farms can make an effective contribution to total rice output if complementary inputs are made available to them by the rural credit system, we require a definition of this category of farms. We define "small farm" as an operational holding which cultivates around 5 acres of land.

CHAPTER TWO

IRRIGATION

The most important characteristic of the new varieties in their ability to absorb high doses of fertilisers. An essential precondition for raising productivity by increased application of fertilisers is the availability of irrigation. Ishikawa regards the technical complementarity between fertilisers and irrigation as being specific to rice cultivation in Asian countries. He defines the category of inputs contributing most to output increases under such complementary relations as "leading inputs".[1] A rigorous definition of complementarity[2] between fertiliser and irrigation input requires the estimation of the relevant production function. Owing to the paucity of data for specifying such a function Ishikawa sought to establish the complementary relations between fertilisers and irrigation by means of simple correlation analysis based on cross-section studies for six Asian countries. Attempts have been made to estimate such functions on the basis of Indian data and these we shall refer to in the next paragraph. In general it is true to say that the interaction between fertiliser input and irrigation has been lost in the econometric wash in most studies.

Using a vast amount of data from experimental stations, Hopper showed that the productivity of nitrogen is higher when used in conjunction with assured water supply.[3] The correlation between fertiliser use and irrigated area in the various states in India was found to be strong and positive. In an econometric study of the demand for nitrogenous

1 Ishikawa, S. Economic Development in Asian Perspective, op.cit., pp 84-87.

2 In the sense that the cross partial derivatives of the demand functions for irrigation and fertilisers with regard to their respective prices is negative.

3 Hopper, W.D. 'Planning Yardsticks for Fertiliser and Irrigation,' ASI, XX, 6 Sept. 1965, pp 463-477.

fertilisers in India, using data for the period 1951-59, Parikh estimated that a 1 per cent increase in irrigated area led to an increase of consumption of fertilisers by 6 per cent.[1] In a later attempt to establish the complementary relationship between fertilisers and irrigation, the same author found his results inconclusive largely due to the lack of data on irrigation rates.[2]

While the above attempts at describing the nature of the relationship between fertilisers and irrigation spells out the role of irrigation, it can be described more fully in the manner of Ishikawa. According to him irrigation has the following three roles to play, namely, stabilising yield fluctuations, making possible the cultivation of a second crop and finally enabling the practice of improved farming techniques.[3] A study of irrigation and yield variability showed that in the rice growing districts of India fluctuations in yield were evened out as a result of providing irrigation.[4] The controlled application of water, signifying the quality of irrigation rather than the quantity is signified by the third role and is particularly relevant in the cultivation of the new varieties of rice. The advent of Higher-yielding varieties has altered the concept of irrigation. Whereas it was traditionally regarded as an insurance against drought and famine, it is now regarded as an input of production similar to seeds, fertilisers and pesticides.[5]

1 Parikh,A. 'Demand for Fertilisers - An Econometric Study,' IJAE, XX, 3, July-Sept. 1965, pp 13-19.

2 Parikh,A. 'Complementarity between Irrigation and Fertiliser in India,' IJAE, XXIV, 3, July-Sept. 1969, pp 1-18.

3 Ishikawa,S. Economic Development in Asian Perspective, op.cit., p 90.

4 Desai,B.R. and Thingalaya,N.K. 'Irrigation Factor and Yield Variability in the Rice-Growing Districts in India,' IJAE, XX, 3, July-Sept. 1965, pp 63-67.

5 Dastane,N. 'New Concepts in Irrigation,' EPW, IV, 13, March 1969, pp A27-A30; Kanwar,J.S. 'From Protective to Productive Irrigation,' EPW, IV, 13, March 1969, pp A21-26; Williams, D.A. 'Water Management in the Seventies,' EPW, V, 26, June 1970, pp A53-A60.

Water requirements of the rice crop, both traditional and HYV, are described in Section II.1 of this chapter. Section II.2 argues that the system of canal irrigation is unsuitable for the cultivation of HYV. The role of tubewells in the cultivation of the new varieties is examined in Section II.3. Section II.4 consists of a short study of the feasibility of tubewells and wells.

II.1. Water Requirements of Rice

Although the irrigation requirements of rice have been most extensively studied, our knowledge of the actual water requirements is meagre.[1] No average conditions can be laid down. Water requirements vary from 38-75 inches per season depending upon the type of soil, its fertility status, and duration of the variety. Tillering[2] to flowering is the most critical period during the growth cycle and water shortage at this stage affects yield adversely.[3] The shallower the depth of water at tillering, the greater is the number of effective tillers produced and the higher the yield. For this reason, the control of water during the growing period is essential. Nevertheless, it is not possible to lay down a rule for the depth of water for optimum growth because the rice plant is characterised by its great versatility. While some do best in moving water, others thrive in stagnant water and still others can withstand water up to 20 feet deep.[4] However, it is generally held that deep water inhibits tillering and results in decreased growth.

An additional reason for the control of water is because rice is most wasteful in its use of water. It is alleged that half the quantity

1 This is because experiments on rice are difficult to carry out accurately owing to the problem of controlling the lateral movement of water from field to field and also because the growing period coincides with the monsoons in India. The problem of flooding during the monsoons is particularly acute in West Godavary, see George,P.S. & Choukidar,V.V. 'Modernisation of the Rice-Paddy System,' IJAE, XXVII, 2, April-June, 1972, pp 14-21.

2 Tillering means the putting out by the plant of several stems from which a fertile head develops.

3 The effect of water shortage at this stage cannot be remedied at a later stage, Anon., 'Water Management Extension Recommendation,' IF, XX, 7, Oct. 1970, p 40; see also Grist,G.H. Rice, Longman, 1965, 4th Edition, p 36.

4 Research workers are unanimous in their belief that cultivation in shallow water out-yields cultivation under deep water, Kung,P. 'Techniques and Procedures for the Management of Rice Culture,' in Mechanisation and the World's Rice, the proceedings of a Conference to support the International Rice Year, 1966, of the Food and Agricultural Organisation of the United Nations organised by Massey-Ferguson, England, Sept. 26-Oct. 1, 1966, p 69.

of water applied to rice is lost through percolation, the average loss of water through seepage, transpiration and evaporation being 0.1 inch per day.[1] The practice of submergence which is the conventional method of paddy cultivation is largely responsible for the loss of water. But the practice of submergence cannot be summarily dismissed and an alternative put in its place without accompanying changes in the system of irrigation. Submergence serves as a reservoir of water for meeting possible water shortage later. Here we are presented with a dilemma. It is this, while drainage of water in fields is necessary, where irrigation facilities are limited and rainfall inadequate, it will endanger the growing crop if it is impossible to re-inundate the fields.[2] True, under the method of submergence there is no means of controlling the depth of water according to the different growth stages and is therefore not suitable for growing the new varieties.[3] But the consideration of submergence as a form of irrigation is important for the insight it provides regarding the nature of irrigation of the new varieties, namely, the controlled application of water pre-supposes an assured supply of water.

1 It has been estimated that it requires 1,500 gallons of water to grow a pound of rice in India, whereas in Japan the same amount can be produced with 300-400 gallons of water, Editorial, IF, XX, 6, Sept. 1970, p 3, see also Government of India, Ministry of Power and Irrigation, Report of the Irrigation Commission, 1972, Vol. I-III, New Delhi, 1972, Vol. I, p 109.

2 Grist, Rice, op.cit., p 36. We shall see later that submergence serves as a method of weed control, see Chapter on Labour below. It is agreed that if paddy fields remain under water for too long, growth is affected because decomposition of organic matter depends upon oxygen and in its absence nitrates cannot be formed. It is interesting to note that there is a basic difference between wheat and rice as far as saturation is concerned. Wheat is intolerant of low oxygen availability whereas rice increases its thriftiness when the soil is saturated, see Rao,V.R. 'Inter-relationship between Irrigation and Drainage with Special Reference to the Problem in Andhra Pradesh,' in Central Board of Irrigation & Power, Symposium on Inter-relationship between Irrigation and Drainage, Publication No. 72, New Delhi, 1972, p 79-99.

3 Experiments conducted at the Central Rice Research showed, however, that even dwarf varieties can tolerate water up to a depth of 7-15 inches of water, Chaudhuri,M.S. and Pandey,R.G. 'New Water Management Practices in Rice,' IF, XIX, 1, April 1969.

Trials conducted in the Rabi season in 1967 by the Central Rice Research Institute for determining the best water management practices for some of the new varieties showed that such practices depended upon the nature of the variety and the season. Of the different practices examined, alternative drying and wetting, submergence of the crop and drainage at the critical tillering stage and submergence till the time of harvest, the first was found to be the most economical in the use of water and also led to higher yields in the case of all varieties.[1] The application of water at the soil-cracking stage also economised the use of water and secured the best yields.[2] Thus, the control of the volume of water and timing of its application and the drainage of fields periodically constitute the new concept of water management.[3]

Under the existing system of canal irrigation water requirements of individual crops have not received adequate attention. This was partly because of the policy of irrigating areas rather than crops as such. The old varieties of rice, owing to their hardy character did not do too badly under this system. The new varieties make more precise demands on irrigation and this renders the large-scale canal irrigation technically unsuitable. Their cultivation calls for a system that permits controlled application of water. Section III examines the role of wells and tubewells which are regarded as being suitable for irrigating the new varieties. But first, we shall discuss briefly the unsuitability of canal irrigation for cultivating HYV.

1 Technical Report for the Central Rice Research Institute for the year 1967 op. cit., pp 29-30.

2 The variety referred to is IR-8, see Chaudhuri,M.S. & Pandey,R.G. 'Rice Responds to Good Water Management,' IF, XVII, 1, Jan. 1968, pp 31-33. It has been found that in India, manuring actually lowers water requirement of crops, farmyard manure being more effective in this respect than inorganic fertilisers, Grist, Rice, op.cit., p 33.

3 Hopper,W.D. & Freeman,W. 'From Unsteady Infancy to Vigorous Adolescence - Rice Development,' EPW, IV, 13, March 1969, pp A17-A21.

II.2. Factors making for the Unsuitability of Canal Irrigation

The object of this section is to show that the system of canal irrigation is unsuitable for the cultivation of HYV. It is argued here that (a) the supply of water is uncertain and (b) the control of water, by which is meant the adjustment of water levels according to the growth cycle of the plant is impossible.

The system of irrigation in Andhra Pradesh is similar to that for the whole country. Broadly speaking there are two kinds of systems, the first consists of diversion works[1] on rivers that are either fed by melting snows or rainfed as in the case of Central and Peninsular India. The second kind consists of storage dams.[2] The irrigation system in Andhra Pradesh contains elements of both systems. The two principal rivers are the Godavary and the Krishna, neither of which is snow-fed and both depend upon the monsoons for the supply of water. The two major irrigation works built since 1947, the Tungabhadra and the Nagarjunasagar Projects also have to depend upon the monsoons for impounding water into their respective reservoirs.[3] In the case of both systems, water is led to the fields by means of canals by gravity or if the physical conditions do not permit, by pumping. Water is distributed among fields by means of permanent open ditches or channels, the flow of water being regulated by headworks or outlets. Table II.1 gives the principal sources of irrigation and the percentage of area irrigated by each of them.

1 Report of the Irrigation Commission, 1972, Vol.I, op.cit., p 179. Diversion works merely raise the level of water in the river to lead water into canals. The capacity of canals to irrigate areas therefore depends upon the nature of the flow in the river. For a brief survey of irrigation in the state see Vol.II, pp 8-20.

2 Ministry of India, Ministry of Information and Broadcasting, Indian Rivers, 1957, New Delhi, p 15.

3 Report of the Irrigation Commission, 1972, Vol. I, op.cit., p 134.

Table II.1. Net Area Irrigated by Sources in Andhra Pradesh 1967-68

Source of Irrigation	Area (acres)	Per cent of net area irrigated
Government Canals	3,170,780	41.5
Private Canals	547,080	0.7
Tanks	3,014,427	39.5
Wells	1,130,165	14.8
Other Sources	260,597	3.5
	7,630,678	100.0

Source: Season and Crop Report, Andhra Pradesh, 1968-69, op.cit., p 9.

Although the irrigation system in Andhra Pradesh was designed primarily for rice cultivation and the terrain in the cultural command area is flat and the soil is more or less uniform in quality, it is inadequate to support the cultivation of traditional varieties let alone the new varieties.[1] This is so on account of a number of reasons. The total amount of water available is small if the monsoon is late or weak. The water is inadequate if the rate of silting in the reservoirs is high.[2] In addition, problems of submergence arise in low-lying areas. Apart from these purely

1 The entire area that can be irrigated by a project is called the cultural command area. It refers to the areas covered by headworks, canals and distributaries. The development of agricultural communities in such areas and the provision of infra-structure, especially, roads and railways constitutes the modern ayacut development programmes. These are in many ways the descendants of the canal colonies of Punjab, Report of the Irrigation Commission, 1972, op.cit., p 133; for details of the development of the Nagarjunasgar ayacut in Andhra Pradesh see ibid., p 137. The cultural command areas of the Tungabhadra Project like that of the Nagarjunasagar project is undulating and its preparation for irrigated agriculture requires considerable investment in men and materials. The ayacut of the former project is particularly important, for, it introduced for the first time, in the fifties, the concept of light irrigation, i.e. the spreading of the benefit of irrigation over a wide area. This concept is, as we shall see later, the source of much of the present disadvantages of the system for the cultivation of new varieties.

2 Ibid., p 179.

physical disadvantages there are real problems connected with the distribution of water. Water is distributed according to a system of rotation. The system whereby each farmer is entitled to receive water periodically arose out of the mis-use of irrigation water in the cultivation of sugarcane on the Godavary canals. Each farmer is required to obtain permission to use irrigation water and is issued a passbook. Before the start of channel rotation an official enters in the passbook the date on which the farmer will get water. He is allowed to irrigate only approved crops and sanctions are generally issued for six years or more.[1]

The principal disadvantage of this type of distribution of irrigation water is that the farmers cannot get water, literally, on tap. Under what is, in effect, a queueing system, water availability on farms need not correspond to the different stages in the growth of the rice plant. Water shortages at critical periods like transplanting and tillering result in a reduction of yields, particularly in the case of traditional, season-bound varieties.[2] What is more, there is no guarantee that water will be available at all should the rotation system be disrupted for technical or human reasons.[3] Assuming that all cultivators in an irrigation block[4] plant seeds at the same time, then the timely supply

1 <u>Ibid</u>., p 114.

2 Lack of water at the flowering stage can reduce yield of rice by 50 per cent, <u>Report of the Irrigation Commission, 1972</u>, Vol. I, <u>op.cit</u>., p 107.

3 <u>Ibid</u>., p 179. This is particularly so if unauthorised irrigation takes place in the upper reaches of the canal.

4 The "Irrigation block" refers to the system of regulation of irrigation known as the "Block System" where cropping patterns are sanctioned in compact blocks which vary in size, <u>ibid</u>., p 144.

of water will be available at the critical period only to that farmer whose turn falls during this stage. The problem for the rest of the farmers is not so much the control of water as the sheer non-availability.

Theoretically, there is no reason why such a distribution system should not serve farmers cultivating the new varieties. As these varieties are not photo-sensitive, the farmer should be able to choose the time of planting in such a way that it corresponds to his turn on the rota. But the difficulties here are of a practical nature. It presupposes very close cooperation between irrigation authorities, extension workers and farmers.[1]

Another practical difficulty is the division of responsibility in the construction of minor canals and channels between irrigation authorities and cultivators. While the construction of main canals and water courses is undertaken by the irrigation department, channels have to be constructed by the beneficiaries of the irrigation system.[2] Although the merit of leaving the construction of channels to the farmers lies in allowing him some degree of control in drawing water, in actual fact it has led to channels being not constructed. The cost of construction being beyond the farmer, especially if the farms are at a great distance from

1 It must be mentioned that efforts are being made to remove organisational bottlenecks in the regulation and distribution of water to the fields, Report of the Irrigation Commission, Vol. I, op.cit., p 139.

2 A "water course" has been defined by the Planning Commission as a channel, built at Government expense, to convey water from an outlet to a block of 16 acres or as may be prescribed. The area for which a water course has to be constructed varies from state to state. Beyond the prescribed limit, field channels have to be built by cultivators to serve various fields within the block; Report of the Irrigation Commission, ibid., pp 142-143.

the outlet has led to insufficient number of channels being laid in the required directions.[1] This is one of the major causes of underutilisation of irrigation.[2]

Under-utilisation of irrigation water is also due to the extreme fragmentation of land. The construction of canals of adequate length is made impossible owing to the obstructive attitude of farmers through whose fields potential users of irrigation water have to divert it.[3]

1 The extent to which the field channels are provided by the irrigation department varies from state to state. In some states they go down to a lower limit of only 5 cusecs, while in others it is 3 cusecs. Water here is spread over a very large area, as large as 300 to 500 acres. Often the distance between a farm and the end of the channel is over a mile. This distance, the prevailing size of farms, and the extent of fragmentation make it difficult for farmers to agree on a mutually agreeable alignment of channels, not to speak of the cost of constructing them. While the cost of digging channels will depend upon the nature of the soil, those constructed in the Tungabhadra project at the state government's expense worked out at Rs 40 per acre at 1969 prices, Anagol,J. 'A Strategy for Ayacut Development under Major Irrigation Projects,' EPW, IV, 26, June 28, 1969, pp A111-A116; see also Central Board of Irrigation and Power, Report on Measures to Accelerate Utilisation of Irrigation Water, Publication No. 71, New Delhi, 1961, p 2.

2 Report of the Irrigation Commission, 1972, Vol. I, op.cit., p 143-144. The report mentions that the realisation of importance of channels in the utilisation of irrigation potential led the Government of Andhra Pradesh to excavate them at its own expense. The Commission recommends that suitable subsidies should be given to farmers to build channels.

3 Legislation for the acquisition of land for the construction of canals does not exist in all states. Where they do exist, the procedure is cumbersome and generally dilatory. In cases where the irrigation authorities have stepped in and constructed the channels on behalf of the farmers, they have had to write off the expenditure owing to the difficulty of recovering the cost from the beneficiaries, Report on Measures to Accelerate Utilisation of Irrigation Water, op.cit., p 2; Evaluation of Major Irrigation Projects, op.cit., p 12. For a summary of the various Irrigation Acts and Codes, see Report of the Irrigation Commission, 1972, op.cit., Chapter XVI, pp 260-274.

Finally, the lack of synchronisation in the completion of reservoirs and the construction of canals may also be listed as a factor making for insufficiency of water on farms.[1]

There is an additional factor connected with the physical design of the system that makes the final delivery of water on farms unpredictable. This is seepage of water owing to the fact that canals and channels are unlined. Seepage losses from main canals is estimated to be about 22 per cent of the total quantity of water discharged at the outlet.[2] One of the consequences of seepage is waterlogging[3] and

1 The Programme Evaluation Organisation observed that this was the case in all the projects save the Lower Bhavani Project, Government of India, Programme Evaluation Organisation, Evaluation of Major Irrigation Projects, Publication No. 50, New Delhi, 1965, p 12.

2 Estimates of seepage losses vary. They range from 25 per cent to 50 per cent depending upon the nature of the soil in the bed and banks of canals and channels; Ahuja,P.R. and Rao,P.S. 'Importance of Investigation in Planning Anti-waterlogging Schemes,' Central Board of Irrigation and Power, Symposium on Inter-relationship between Irrigation and Drainage, Publication Number 72, New Delhi, 1972, pp 30-45; Report of the Irrigation Commission, 1972, Vol. I, op.cit., p 117. Recent experiments for determining water requirements for rice on loamy soil showed that out of 66 inches of water needed by the crop, 47 inches was lost by percolation and only 19 inches met the crops actual consumption. This shows the extent of percolation loss in relation to the consumptive use of water by the rice crop, ibid., p 108-109.

3 Waterlogging is also caused by the practice of unauthorised irrigation often done by farmers by breaching bunds, Evaluation of Major Irrigation, op.cit., p 139; Report of the Irrigation Commission, 1972, Vol. I, op.cit., p 109.

salination.[1] Waterlogging injures the root system of the rice plant and results in low yields.[2] This is also caused by over-irrigation. Like the practice of submerging crops, over-irrigation is a consequence of the uncertainty of water supply. Low water rates and the existing system of distributing irrigation water are also factors making for the indiscriminate use of water.[3] Waterlogging has been observed in all the major irrigation works.[4]

The above description indicates that both the inadequate length of canals and seepage of water from them lead to uncertainty of water supply under a system of canal irrigation.[5] Control of water has two aspects

1 Most irrigation water contains about ½ to 3 tons of salt per acre-foot. (An acre-foot of water is the amount of water that will stand a foot deep on an acre of land assuming that there is no percolation.) In the absence of proper drainage the water-table rises and the subsequent evaporation of saline water results in large quantities of salt being deposited in the root zone. This injures the rice crop, Carter,L.M. A World Geography of Irrigation, Oliver and Boyle, Edinburgh, 1970, p 48.

2 Report of the Irrigation Commission, 1972, Vol. I, op.cit., p 109.

3 Hoon,R.C. 'Interaction between Irrigation and Drainage,' in Symposium on Irrigation and Drainage, op.cit., pp 70-78; for the impact of low water rates on over-irrigation see, Anon, 'Interaction between Irrigation and Drainage, ibid., p 17.

4 Evaluation of Major Irrigation Projects, op.cit., p 14. No regular statistics is maintained regarding the waterlogged areas in India and the rate of their increase. Generally speaking, the problem is more acute in the Indo-Gangetic plains which have bad slopes.

5 In Peninsular India, except for isolated areas in the Deccan canal area, water-logging is not a serious problem of good drainage, Ahuja,P.R. & Rao,P.S. 'Importance of Investigation in Planning Anti-Waterlogging Scheme,' Central Board of Irrigation and Power, Symposium on Inter-relationship between Irrigation and Drainage, Publication No.72, New Delhi, 1972, pp 32-33.

(1) control over the total volume of water that is required for a crop in a given season and (2) the ability to apply this amount in varying quantities according to the water requirement of the crop at different stages in the growth cycle. While the system of canal irrigation possess, on the whole, some degree of controllability of the first type, in the sense that the supply of water is more certain than under rain-fed conditions, there is no means of exercising control of the second type.[1] For this purpose we need highly developed procedures and equipment for measuring water supply such as meters, division boxes for dividing water into streams, weirs, control gates, etc. In effect, it means the replacement of the supply of water on an area basis by that on a volumetric basis. We come full circle here because irrigation on an area basis was adopted, following the recommendations of the First Irrigation Commission, on account of the difficulty of supplying water on a volumetric basis. The chief argument advanced by the Commission, *à propos* the fixation of water rates on a volumetric basis, was the prohibition cost of installing water meters on a large number of small farms.[2] Ansari, in a reconsideration of the Commission's arguments,

1 This is not to suggest that water is released from canal outlets without regard for the duration of crop. In the Tungabhadra Project, paddy is sown in April and is harvested in mid-January. The crop receives water for three and a half months, the distribution of water during this period being 15 waterings at a depth of 3 inches per watering, *Evaluation of Major Irrigation Projects*, *op.cit.*, p 90; *Report of the Irrigation Commission*, 1972, *op.cit.*, pp 187-189.

2 For a summary of the Commission's objections to volumetric charging see Ansari,N. *Economics of Irrigation Rates - A Study in Punjab and Uttar Pradesh*, Asia Publishing House, London, 1968, pp 110-111.

while admitting that the chief obstacle is the cost of installing devices for the measurement of water on farms, observes that sufficient experimentation has not been done in this field.[1] Perhaps this was due to the preoccupation with the fixation of water rates on a volumetric basis rather than the measurement of water supply *per se*. It is to be hoped that with the increasing recognition of the need for controlled irrigation in the cultivation of HYV, the latter aspect of irrigation will receive more attention. Volumetric control, and indeed, volumetric charging is operative in the case of state tube-wells.[2]

Both types of control of water supply are required to grow HYV rice successfully. The first type can be achieved by the irrigation authorities undertaking the construction of channels themselves and not leaving it to individual cultivators and by state governments passing and enforcing legislation regarding the acquisition of lands for the construction of canals.[3] To the extent that uncertainty of water supply is due to loss of water through seepage, the lining of canals and channels will lead to assured water supply on the farms. If the uncertainty of water supply is due to loss of water through seepage,

1 Ansari, N. *Economics of Irrigation Rates - A Study in Punjab and Uttar Pradesh*, op.cit., pp 110-111.

2 Government of India, Programme Evaluation Organisation, *Study of the Problems of Minor Irrigation*, Publication No. 40, New Delhi, 1961, pp 149-151.

3 The alternative here would be to reduce the size of the cultural command area as suggested by the authors of the *Report on Measures to Accelerate Utilisation of Irrigation Water*, *op.cit.*, pp 2-3.

then a possible solution would be the lining of canals and channels. Again, if the uncertainty is due to distributional arrangements like the warabandhi system, then the control of water supply can be achieved by the sale of water. These are all theoretical possibilities of controlling water supply. Their actual implementation will depend upon their economic feasibility. As it is not possible to discuss the economic feasibility of each and every means of controlled irrigation we shall confine our attention to tubewells. This is done in the following section. In passing, however, we shall note briefly the economics of lining canals and channels in order to have some idea of the additional cost that will have to be incurred if the existing system of canal irrigation is to be adapted for the cultivation of the new varieties.

It was discussed earlier, that one way of ensuring adequate water supply on farms would be for the Government to undertake the construction of channels at present left to the initiative of the cultivators. It has been estimated that such extension would increase irrigation costs per acre in the order of Rs 15-Rs 25, the cost per acre of providing irrigation water being Rs 400-Rs 900.[1] The absence of channels of adequate length is one of the causes of under-utilisation of irrigation potential. Following the example of the state of Mysore in 1966, where it was discovered that excavating channels at the Government's expense amounted to only 3.2 per cent of the total cost of the Tunghabhadra project, the Government of Andhra Pradesh undertook to extend channels under the Nagarjunasagar project with beneficial results.[2]

1 Report on Measures to Accelerate Utilisation of Irrigation Water, op.cit., pp 2-3

2 Report of the Irrigation Commission, 1972, Vol. I, op.cit., pp 143-144. The Commission recommended that in the event of state Governments not undertaking the construction of channels, subsidies should be paid to cultivators, ibid. Anagol estimated that the construction of field channels accounted for less than 1 per cent of the per acre investment required for intensive development of the ayacut of the Tungabhadra Project, Anagol, 'A Strategy for Intensive Development under Major Irrigation Project,' op.cit., p A113.

The case for lining is based on the claim that whereas an unlined canal may have an absorption loss as high as 8 cusecs per million square feet of wetted perimeter, a lined canal is not expected to lose more than 2 cusecs per million square feet.[1] Apart from the loss of water by seepage from unlined canals, it leads to high cost of weed clearance, frequent repairs and heavy silting leading to further costs of maintenance.[2] Thus the initial saving in investment by the construction of unlined canals is likely to be more than offset by the latter costs. A comparison can be made here with another situation also related to irrigation. In the case of some irrigation projects, the saving in cost per unit volume of dam wall has been offset by the high cost of building the network of canals. For example, the ratios of the cost of distribution to that of storage are 0.9 and 2.2 in the case of Hirakud and Bhakra-Nangal respectively.[3] Despite the technical superiority of lined canals and channels, they have yet to prove economical. In common with other states there is no provision for the lining of canals in the Irrigation Plans of Andhra Pradesh.

1 Singh, J. 'Economic and Optimum Utilisation of Irrigation Supplies' in Central Board of Irrigation and Power, Symposium on Economic and Optimum Utilisation of Irrigation Supplies, Publication No. 71, New Delhi, 1961, p 146.

2 Report of the Irrigation Commission, 1972, pp 117-118.

3 Clark.C. The Economics of Irrigation, Pergamon Press, London 1970, p 68.

Such plans in relation to the Tungubhadra project were dropped on account of the high expenditure involved.[1] Whether wholesale lining should be resorted to will depend upon the net benefits from lining as evaluated by cost-benefit studies. The benefits from lining are of the following nature: saving in irrigation water due to reduction in seepage, reduction in labour required for irrigation,[2] reduction in annual maintenance costs and saving in land cost and earth works.[3] Annual costs per foot length are of the following kind: capital cost of construction, annual maintenance cost, rate of interest on capital and depreciation. The above factors vary significantly from farm to farm and not much data is available on them. The Second Irrigation Commission refers to the cost of lined channels being two to three times that of unlined ones for an equivalent rate of discharge of water.[4] If it is so, the monetary benefits will have to be adequate to justify the expenditure incurred on lining. Cost-benefit studies of lining of irrigation channels are few and far between.[5] What must be emphasised here is that what attempts

1 Evaluation of Major Irrigation Projects, op.cit., p 101.

2 According to one estimate, it takes two man-days per year to maintain an acre of unlined channel, i.e. for cleaning weed growth, repairing breaches, clearing silting, etc. Joseph, A.P. 'Lining of Irrigation Channels,' IF, XVII, 10, Jan. 1968, p 42.

3 Report of the Irrigation Commission, 1972, Vol. I, op.cit., p 117.

4 Ibid. p 118.

5 Using data for the Punjab for 1968, Joseph calculated the benefit-cost ratios for lining a channel 125 feet long on a 20 acre farm served by a private tubewell with a capacity of 0.5 cusecs. A rate of 30 cusecs per million square feet or 1.3" per hour was assumed as seepage loss. Four different types of lining materials were considered, brick and cement lining, buried hume pipe, bituminos lining and mud plaster. By making assumptions regarding the life-span of the lining materials and assuming a six per cent rate of interest on capital borrowed for undertaking the investment he found that lining the channel with the first three types of materials was economical whereas the last was not, Joseph, A.P. 'Lining of Irrigation Channels,' op.cit., pp 41-43.

have hitherto been made to evaluate the net benefits from lining channels have been done largely in relation to the problem of waterlogging rather than as exercises in the controlled application of water. In fact, the high opportunity cost of lining canals has led to the problem of waterlogging being solved by evolving systems of drainage along with the construction of major and minor irrigation works. Even here, anti-waterlogging measures have been generally dovetailed with measures of flood control.[1] In Andhra Pradesh, owing to adequate drainage, waterlogging is not a serious problem so that the role tubewells, which constitute an anti-waterlogging device can be assessed primarily as a means of controlling the supply of water.

Turning now to the control of water supply by the sale of canal water, we find that this is a non-starter in so far as the State Governments have the sole monopoly in the sale of water. Farmers cannot resell water legally. Explicit reference to the fact of non-saleability will not be found in irrigation statistics, but is implied in the ownership of irrigation works.[2] It is in this respect that private tubewells have an advantage over state-owned irrigation projects. The proponents of this scheme, Gustafson and Reidinger[3] argue that the sale of water will lead do more productive use of water. Borrowing from the experience of Spain they argue that apart from making the price of canal water more realistic,[4]

1 Fourth Five Year Plan, op.cit., pp 259-260.

2 For example the Madras Irrigation (Levy of Betterment Contribution) Act 1955 (Madras Act III of 1955), see Government of India, Ministry of Food and Agriculture, Directorate of Economics and Statistics, Agricultural Legislation in India, Agricultural Taxes, Vol. IX, New Delhi, 1964, pp 501-502.

3 Gustafson,W.E. & Reidinger,R.B. 'Delivery of Canal Water in North India and West Pakistan,' EPW, VI, 52, Dec. 1971, pp A157-162.

4 Refer pp 86 - 87 below.

the sale of water will lead to greater certainty of supply. To facilitate such sale they recommend the setting up of water users' associations. Such associations will contract with the Government for delivery of water and the actual allocation will be done by the members themselves. The operation of such a system in any of the states in India would mean that their agricultural and irrigation departments would have to relinquish their monopoly power with regard to the distribution of water. The idea of water users' association is not an innovation in India, for, the Panchayats are largely responsible for drawing up the list of farmers under the warabandhi system. What is more, there is no guarantee that, as in matters like credit, such associations will not become the rich farmers' club.

The conclusions of this section are that whereas the setting up of the system of canal irrigation was adequate to carry on rice cultivation by traditional methods and did in fact help increase irrigated acreage, the system is neither adequate to supply the required amount of water in fields nor flexible enough to meet the needs of scientific agriculture. With the itensification of land use as a result of the cultivation of HYV, the demand for water, especially the distribution of demand over the duration of the crop has changed and the peak requirements have become accentuated. As the lack of assured and controlled water supply imposes a limit upon the rate of growth of crop output, the need arises for an alternative system of irrigation. The alternative system considered by us as being suitable consists of surface wells and tubewells. Technically, they permit the controlled application of water and ensure adequate supply. Their effective use on farms depends upon their economic feasibility. The last section examines in detail the economic feasibility of wells and tubewells in West Godavary.

II.3. The Role of Tubewells in the Cultivation of Higher-Yielding Varieties of Rice

Much of the success of higher-yielding varieties of rice in Punjab is ascribed to the use of tubewells in irrigation.[1] Tubewells are sunk by machinery and are so called because the well shaft which is only a few feet in diameter is lined with steel tubing which is perforated when it meets water-bearing material at depths of 400 and 500 feet. Water comes into the shaft through the perforation and is lifted to the surface by a pump driven either by a diesel of electric engine. In the deltaic area where the sub-soil is soft, tubewells are sunk by hand-boring sets. These have a depth of only 40-50 feet.[2] Here again the water is lifted to the surface by diesel or electric pump.

1 Since the introduction of HYVP the role of tubewells has undergone a qualitative change. They have emerged from being a source of supplementary irrigation to a primary source of water supply on farms. The development of tubewells as a form of minor irrigation received encouragement in 1943 under the Grow More Food Campaign. The advent of planning saw the setting up of the Exploratory Tubewell Organisation under the Union Ministry of Agriculture in 1954. This organisation undertakes the exploration and the assessment of the supplies of ground water, the actual development of the sources being left to state government and private owners. The construction of tubewells in the past has been largely confined to the states of Punjab and Uttar Pradesh as the Indo-Gangetic Plain is the principal underground water region in India, Central Board of Irrigation and Power, Tubewells and Groundwater Resources, Publication Number 69, New Delhi, 1961, pp 120-121; Report of the Irrigation Commission, 1972, op.cit., pp 49-54. For the contribution of tubewells to the success of HYVP in Punjab, see, Williams, 'Water Management in the Seventies,' op.cit., pp A53-A60; Sen,A. 'Opportunities in the Green Revolution,' EPW, IV, 13, March 1970, p A33; Anon. 'Groundwater Resources for Irrigation in India,' Reserve Bank of India Bulletin, XXIV, 9, September 1970, pp 1507-1522.

2 Tubewells here are also referred to as filter points; Tubewells and Groundwater Resources, loc.cit.

The specific problem investigated in this section is the comparative economic advantage of tubewells over other forms of minor irrigation in the paddy growing tracts of Andhra Pradesh. The hypothesis to be tested is that owing to some technical and economic factors, tubewells have no special advantage as means of controlled advantage in Andhra Pradesh. Emphasis must therefore be placed on the development of existing forms of irrigation like tanks and wells.[1] Wells when energised possess, to a large extent, the advantages claimed for tubewells. Evidence to prove this hypothesis has had to be taken from a variety of sources. On account of the limited amount of work done on the economics of tubewell irrigation in rice cultivation, it has been necessary to draw upon the experience of states where tubewells are prevalent, albeit wheat growing ones. The relative superiority of wells in the cultivation of HYV is demonstrated by the application of the method of micro-analysis of feasibility evolved by the Reserve Bank of India as a result of special field studies undertaken by it in relation to the refinance proposals received by the Agricultural Refinance Corporation since 1964.[2] Details of the methodology are spelt out in the concluding section of this chapter. Brief descriptions of the principal forms of minor irrigation are given in this section.

1 We have already noted the importance of these forms of irrigation in Andhra Pradesh, refer p68 above.

2 The Agricultural Refinance Corporation was established in 1963 to finance schemes of agricultural development such as land reclamation, rural electrification, minor irrigation, etc. proposed by State Cooperative Banks, Land Mortgage Banks and Commercial Banks who are its shareholders. It was set up primarily to augment the resources normally made available by existing credit institutions like cooperatives, either because of large outlays involved or because of special conditions of repayment. In the sphere of irrigation it has helped to construct 13,240 tubewells, 4,982 dug wells and has renovated 635 old wells. A number of these wells have been energised and the Corporation envisages a close co-operation with the Rural Electrification Corporation, Notes 'Agricultursl Refinance Corporation,' RBIB, XXIII, 11, Nov. 1969, pp 1799-1801, Reserve Bank of India, Financing of Agriculture by Commercial Banks, Report of a Seminar held in Bombay on Dec. 6-8, 1968, Bombay, 1969, pp 260-270.

Several advantages are claimed for tubewells in the cultivation of HYV. They are a dependable source of water supply as underground water is subjected to less fluctuations in supply than in overhead reservoirs and stream flows which depend upon rainfall. Tubewells permit the controlled application of water, for, crops can be irrigated according to their water requirements at different stages of growth. They can be sited at or near locations where they are used and involve smaller investment in distribution network than major irrigation projects do. Compared to the latter, they also have a shorter gestation period.

The above advantages of tubewells have to be set off against the costs of installation and maintenance. Irrigation by tubewells is more expensive than other forms of minor irrigation. We are seriously handicapped here for lack of data regarding tubewells in Andhra Pradesh. Some idea of the relative costs of irrigation by minor irrigation works can be had from a comparison of water rates. This is given in Table II.2. below.

Table II.2. Cost of Irrigation by Canals, Tubewells and Wells in Selected Area.

State	Type of Crop	Cost of Irrigation (Rs/a)		
		Wells	State Tubewells	Government Canals
Gujerat	Heavily Irrigated Crop	60-75	-	12-28
Andhra Pradesh	Wet Crop	300	-	50
	Lightly Irrigated Crop	60	-	15
Uttar Pradesh	Paddy	-	25	5
	Sugarcane	-	38	25
	Wheat	-	14	10

Source: Study of the Problems of Minor Irrigation, op.cit., p 73.

Note: The cost of well irrigation includes the imputed value of family labour and as such does not represent out-of-pocket expenditure which the rates of other types of irrigation do.

In any study of the costs of tubewell irrigation, a distinction has to be made between state and private tubewells.[1] In common with all other types of minor irrigation works, the costs of installation and maintenance and the extent of utilisation depend upon the nature of ownership. State tubewells are constructed, maintained and operated by state Governments.[2] Technically, state tubewells have a greater drilling depth and have a higher rate of discharge of water than private tubewells. Whereas the former has a rate of discharge of approximately 30,000 gallons per hour, private tubewells have a rate of discharge of only 11,000 gallons per hour.[3] The higher rate of discharge enables state tubewells to have a larger cultural command area. Whereas they can irrigate between 250 and 350 acres, private tubewells can irrigate only 10-30 acres.[4] Cost-wise, 50 per cent of the annual capital cost is accounted for by fixed costs in the case of state tubewells, whereas they form only 43 per cent in the case of private tubewells.[5] The location and costs of tubewells constructed by the Exploratory Tubewell Organisation in West Godavary is given in Table II.3.

1 The Irrigation Commission, 1972, does not make explicit reference to this distinction.

2 State tubewells are maintained by funds provided by annual budgets in the respective states, 'Groundwater Resources for Irrigation in India,' op.cit., p 1572.

3 Groundwater Resources for Irrigation in India, pp 1508-1509. In the Deccan, for geological reasons, tubewells whether state or private have a lower rate of discharge than those in the Indo-Gangetic Plain. The average is 6,000 gallons per hour, National Council of Applied Economic Research, Techno-economic Survey of Madras, New Delhi, 1961, p 86.

4 Groundwater Resources for Irrigation in India, op.cit., pp 1508-1509.

5 Mellor, J.W. & Murthy,T.V. 'Dilemma of State Tubewells,' EPW, VI, 13, March 1971, pp A37-A44.

Table II.3. State Tubewells in West Godavary, 1958

Location of Tubewell	Depth of Tubewell in feet	Area Irrigated Acres	Cost of Tubewells Rs	Estimated Cost of Irrigating one Acre in the Kharif Season Rs
Gunaampalli	509	140	65,716	58
Nallamadu	186	59	51,879	108
Nallajerla	400	51	68,630	51
Venkataraman-nagudem	407	70	63,985	-

Source: Report of the Irrigation Commission, 1972, Vol.III (Part 2), p 143.

Note: The tubewells referred to are all operated by diesel engines. The location refers to *tehsils* in West Godavary.

Unlike canal irrigation where water rates are fixed on the basis of area irrigated, water from state tubewells is charged volumetrically. One cannot, however, be too categorical about this because, going by the experience of states in India where state tubewells have had a longer history, the practice of volumetric assessment has not been strictly adhered to.[1] As yet no definite criterion for fixing rates for irrigation

1 There are wide differences in the methods of charging for water from state tubewells in the states of U.P., M.P. and Punjab. In the first two states water is supplied on a volumetric basis. In Punjab the supply of water on farms is charged according to the electricity consumed in pumping water, Report of the Irrigation Commission, 1972, Vol.I op.cit., pp 274-275. In Bihar, on the other hand, the provision of tubewell water is regulated by a system of leasing and is charged on the basis of area irrigated, Parthasarathy, C.S. 'Water Rates for Irrigation,' Indian Journal of Power and River Valley Development, XV, 10 & 11, Oct.-Nov. 1965, pp 8-21 and 19-31. Thus we see that although, technically, state tubewells permit volumetric assessment, in practice this has not necessarily been so.

water from tubewells has been evolved. The problem is very much part of the system of irrigation charges in India.

The system of irrigation charges in India has evolved as a result of several historical and ad hoc factors. Irrigation being a state subject, there are wide regional differences in water rates. Although, theoretically, the criterion governing investment projects should provide the basis for rate fixation, the practice in India is to fix water rates as a certain proportion of gross income or gross produce. The Nijalingappa Committee recommended that water rates should be fixed at 25 per cent to 40 per cent of the additional net benefit per acre of crop output, taking into account water requirement of crop, rainfall, yield rate, etc. These proportions apply to areas where it is possible to calculate net benefits. Where it is not possible, the Committee recommended that the rate should lie between 5 per cent and 12 per cent of gross income.[1] This is also the recommendation of the latest Irrigation Commission.[2] This rate applies to both water from canals and tubewells. At present in Andhra Pradesh the charge for using canal or tubewell water is Rs 33.4 per acre of land irrigated.[3] It constitutes a mere 2.6 per cent of the gross value of crop produced by the aid of irrigation.[4] Water rates are in general low in all the states in India,[5] both in terms of what the farmers can pay and in terms of what irrigation authorities should charge to make irrigation projects economically viable. Existing water rates do not even meet interest charges on investment.[6] There is a large element of non-economic considerations (i.e. the desire to popularise irrigation) and administrative decision-making in the fixation of water rates in India. An example of the latter is that in

1. Government of India, Ministry of Irrigation & Power, Report of the Committee to Suggest Ways and Means of Improving Returns from Irrigation Projects, New Delhi, 1964, also called the Nijalingappa Committee.

2 Report of the Irrigation Commission, 1972, Vol.I, op.cit., pp 274-276.

3 Report of the Irrigation Commission, 1972, ibid., pp 271-272.

4 Ibid.

5 The rates in the rice growing states range from 1 per cent of the gross value of produce in Punjab to 7 per cent in Bihar, ibid.

6 Srinivasan, N. Agricultural Administration in India, op.cit., p 196.

South India, in the Godavary Delta Scheme it was found administratively convenient to combine irrigation charges with land revenue and to recover a consolidated amount from farmers.[1] Also, attempts to fix water rates on economic grounds have always been thwarted by political reasons, for, state government find it expedient to keep water rates low. Thus in the fixation of water rates in India we see the departure from all known theoretical criteria.[2] The recommendations to increase water rates by both the Nijalingappa Committee and the Fifth Finance Committee have, by and large, been ignored.[3]

Private tubewells may be owned individually or collectively by two or more cultivators. Their construction may be financed either by farmers' own funds or by loans provided by Land Mortgage Banks, Central Cooperative Banks and commercial banks.[4] Ownership of groundwater rest with owners of the overlying land.[5] There is no restriction on the owners' right of the use of water which he is free to sell in amounts and at rates of their choosing.[6] The latest Irrigation Commission found that, in general, owners of tubewells sold water on a crop-sharing basis taking one-third of gross produced.[7]

1 Report of the Irrigation Commission, 1972, op.cit., p 265.

2 Although rate fixation of irrigation projects falls within the scope of pricing policy of public utilities, it raises a number of problems specific to itself. These are competently discussed in the following works: Ansari,N. Economics of Irrigation Rates, A Study of Punjab and Uttar Pradesh, Asia Publishing House, London, 1968; Gadgil,G.R. Economics of Irrigation, Gokhale Institute of Politics and Economics, Poona, 1948; National Council of Applied Economic Research, Criteria for Fixation of Water Rates and the Selection of Irrigation Projects, Asia Publishing House, Bombay 1959.

3 Report of the Committee to Suggest Ways and Means of Improving Financial Returns from Projects, op.cit., p 5; Anon, 'Report of the Fifth Finance Commission - A Summary,' RBIB, XXIII, 9, Sept. 1969, pp 1429-1453.

4 Anon, 'Groundwater Resources for Irrigation in India,' op.cit., p 1511 for the role of the Agricultural Refinance Coorporation in this connection should be recalled.

5 Report of the Irrigation Commission, 1972, op.cit., p 362. Owing to the importance of groundwater for irrigation some states have enacted legislation regulating the use of tubewell water.

6 Ibid. p 271.

7 loc.cit.

The total number of private tubewells for the state of Andhra Pradesh during the Planning period is given in Table II.4.

Table II.4. Private Tubewells including Filter Points (Pre-Plan - 1968/69)

Pre-Plan	First Plan	Second Plan	Third Plan	Total up to 1968/69
1	2	3	4	5
16,197	18,000	23,000	26,000	28,000

Source : Column 1 Dhar,U., 'Some Economic Factors in the Expansion of Electricity in Rural Areas,' IJAE, XXIV, 4, Oct.-Dec. 1969, p 169. Columns 2-5 'Groundwater Resources for Irrigation in India,' op.cit., pp 1521-1522.

The table shows that the number of tubewells increased by 5 per cent over the Planning period and taking the area under rice cultivation in 1967-68,[1] the total number of tubewells in the state in 1968-69 represents only 0.02 per cent per acre. In West Godavary alone, plans for the exploitation of groundwater resources under the Intensive Agricultural District Programme envisaged the construction of 7,500 tubewells but in 1968-69 the total number of tubewells stood at 2,382 representing about a third of the target.[2] In terms of the size distribution of tubewells in the district, Table II.5 shows that farms above 3 acres but below 10 acres accounted for 70 per cent of the total number of tubewells in West Godavary.

1 Total area under rice in Andhra Pradesh in 1967-68 was 1,359,766 acres, Season and Crop Report, Andhra Pradesh, 1967-68, op.cit., p 16.

2 George,P.S. & Choukidar,V.V. Production and Marketing Pattern of Paddy, op.cit., p 18.

Table II.5. Number of Tubewells in West Godavary according to Farm Size, 1968-69.

Farm Size (acres)	Number of Tubewells	Percentage to Total
1	2	3
Below 3	703	5
3 - 5	4476	33
5 - 10	5941	44
Above 10	2382	18
	13502	100

Source: George,P.S. & Choukidar,V.V. Production and Marketing Pattern of Paddy, op.cit., p 18.

The figures in Tables II.4 and II.5 give us an idea of the number of tubewells in West Godavary and the state as a whole. Time series data for the state and the district is fragmentary. To the extent that electric pumps and oil engines complement the use of private tubewells, growth of the former between 1951 and 1966 give some indications regarding the growth of the latter. Table II.6 shows the rate of growth of electric engines and diesel engines and other relevant information. The rate of growth of electric engines was higher than that of oil engines.[1] In the case of both types of equipment, farms above 5 acres accounted for 42 per cent of the total.[2]

1 The rate of increase was more pronounced, taking the period 1961-69 as a whole, 'Groundwater Resources for Irrigation in India,' op.cit., p 1515.

2 Refer Columns 8 & 9, Table II.6, below.

Table II.6. Electric Engines and Oil Engines in Andhra Pradesh, 1951-66

Number per 1000 acres of irrigated area (excluding canals)				Annual Average Increase per cent per annum			Number of Cultivating Households per Electric/Oil Engine, 1961	
1951	1956	1961	1966	1951-56	1956-61	1961-66	All Sizes	5 acres & Above
1	2	3	4	5	6	7	8	9
Electric Engines								
0.44	0.82	4.37	13.22	23.57	85.74	47.23	220	93
Oil Engines								
2.4	4.25	8.71	10.80	21.62	20.47	7.54	110	46

Source: Anon, 'Trends in Farm Mechanisation,' RBIB, XXVI, 2, Feb. 1972, pp 244-245.

Construction of private tubewells is technically feasible in the Godavary Delta.[1] The ability of farmers to invest in them depends upon their ability to afford the cost of installing both the tubewell and electric or oil engines. In the deltaic region of West Godavary, the cost of installing a private tubewell varies from Rs 500 and Rs 2000. An electric engine of 5 h.p. costs Rs 2500 and an oil engine of 5 h.p. costs between Rs 3500 and Rs 4000 in 1969. The total cost of installing a tubewell complete with electric engine is, roughly, Rs 3000 and one equipped with oil engine will be about Rs 6000.[2] We shall draw upon these figures in the next section where we will discuss the feasibility of investing in tubewells.

1 Report of the Irrigation Commission, 1972, Vol. III (Part 2), op.cit., p 145.

2 Frankel,F.F. India's Green Revolution, Economic Gains and Political Costs, Princeton University Press, New Jersey, 1971, p 95. Estimates of the cost of installing private tubewells in Andhra Pradesh are hard to come by and what is available refers to the states of Uttar Pradesh and Punjab. In our study of feasibility of constructing private tubewells we have used the figure of Rs 4000 for an electrically operated one. The use of the figure will not be misleading as this is the cost of installing such a tubewell in Thanjavur which has geographical characteristics similar to West Godavary, Mirchandani,G.G. (Ed.) Aspects of Agriculture in India, Allied Publishers, London, 1973, p 347.

We turn now to the chief characteristics of pucca wells[1] as a form of minor irrigation. Wells form the most important source of groundwater in Andhra Pradesh. They account for nearly 11 per cent of total area irrigated.[2] If the deltaic areas favour tubewells, the non-deltaic areas are eminently suitable for irrigation by surface wells.[3] They possess advantages similar to tubewells, both private and public and in some ways are superior to them. They are perennial sources of supply of water, have smaller cultural command areas and have a longer life span than tubewells.[4] Although we have no estimates of the yield of wells in terms of water in them, for the Godavary Basin as a whole each well helps irrigate approximately one-half of an acre per day.[5] The majority of pucca wells are privately owned. This is an important consideration because there is an inverse relationship between the continuity in use and maintenance of wells and the extent of separation from ownership and use of wells. Government wells tend to be badly maintained judging by the higher proportion of such wells out of use compared to private wells. Whereas 30 per cent of the total number of Government wells were out of use only 5 per cent of the privately owned ones were in this condition.[6]

1 Pucca wells refer to masonry wells usually 40-50 feet deep.

2 Report of the Irrigation Commission, 1972, Vol. III, (Part 2), op.cit., p 128.

3 National Council of Applied Economic Research, Techno-Economic Survey of Andhra Pradesh, New Delhi, 1962, p 18.

4 Study in the Problems of Minor Irrigation, op.cit., p 83.

5 Report of the Irrigation Commission, 1972, Vol. III, (Part 2), op.cit., p 146. The RBI study on groundwater resources mentions that a pucca well in Andhra Pradesh irrigates 1.5 acres per day, 'Groundwater Resources for Irrigation in India,' op.cit., p 1509.

While wells possess considerable technical advantages compared to tubewells, the per acre cost of irrigation is the highest. Cost per acre of different forms of minor irrigation (wells and tubewells) are set out in Table II.7.

Table II.7. Costs of Different Types of Well Irrigation, All-India, 1961-69

Type of Wells	HP	Capacity gallons/hour	Cultural Command Area (acres)	Cost of Construction + Cost of Electric/Oil Engine (Rs)	Cost per acre of Cultural Command Area (Rs)
1	2	3	4	5	6
Well + Persian Wheels	-	-	0.50	3000-3500	1500
Well + Diesel Engine	5	5000-15000	5 - 15	5500	550
Well + Electric Engine	5	"	"	3500-4000	233-800
Private Tubewell (Diesel)	-	7000-8000	10 - 30	5500-8500	183-850
Private Tubewell (Electric)	-	"	"	4000-6500	133-650
State Tubewell (Electric)	-	20000	250 - 350	40000-65000	144-260

Source: Columns 1-5 'Groundwater Resources for Irrigation Development in India,' op.cit., pp 1508-1509.
Column 6, calculated from columns 4 and 5.

The high per acre costs of well irrigation, even wells fitted with Persian wheels,[1] is due largely to the high labour costs in their construction and maintenance. We have no figure for the order of magnitude of such costs in Andhra Pradesh, but those relevant for Mahrastra used by Lal in hist cost-benefit study of wells in Maharashtra[2] enable us to have a rough idea. The

1 The Persian Wheel is a mechanical device for lifting water, see Grist, Rice, op.cit., p 41.

2 Lal, D. Wells and Welfare - An Exploratory Cost-Benefit Study of the Economics of Small Scale Irrigation in Maharastra, Development Centre of the Organisation for Economic Organisation and Development, Paris, 1972.

cost of constructing wells consists of costs of digging and lining[1] and these vary according to the diameter and depth of well and the nature of rock structure.[2] Nearly 70 per cent of the costs of digging a well is on account of labour.[3] The use of this proportion in relation to the cost of constructing wells in Andhra Pradesh will not be inappropriate because the geological structure of the Deccan Plateau where the two states lie are very similar.[4] In using this proportion it must be remembered that the costs referred to are those calculated on the basis of shadow prices which reflect the existence of surplus labour.[5] According to an estimate made by the Reserve Bank of India, the cost of constructing a well in Andhra Pradesh is Rs 2000 of which 70 per cent or Rs 1400 can be assumed to represent labour costs.[6]

1 Wells on soft earth require to be lined with stones, Wells & Welfare, p 69.

2 Wells on soft earth are dug by manual labour and labour costs vary according to depth of well. For a typical well, constructed on soft earth in Mahrastra measuring 17½ feet in diameter and 22½ feet in depth the proportions of labour costs to total costs are the following 82 per cent, 13 per cent and 11 per cent respectively, Wells and Welfare, op.cit., pp 83-84.

3 Ibid., p 65.

4 Report of the Irrigation Commission, 1972, Vol. I, op.cit., p 146.

5 One cannot stress too strongly, the extreme caution that must be taken in the application of this figure based as it is on shadow prices of farm labour. The important assumption here is that the farm economies in terms of total labour available on farms in the two states under consideration are similar. As we are interested in only a rough order of magnitude of labour costs involved in constructing wells these difficulties are here acknowledged and assumed away.

6 'Groundwater Resources for Irrigation in India,' op.cit., p 1509.

Not only are the labour costs a high proportion of the total cost of construction of wells high, but the lifting of water, either by pulleys or contraptions like the Persian Wheel is highly labour intensive. In the case of the latter a pair of bullocks and two men are needed each time water is lifted.[1] Irrigation costs here will include the wages of field labourers and the maintenance of bullocks. These can be reduced by the installation of pumpsets for lifting water. The trend is already under way to instal electric pumps in Andhra Pradesh. The actual number of pumpsets increased approximately five-fold from 18,000 to 98,000 in 1968.[2] Andhra Pradesh, in common with Tamil Nadu, Punjab and Maharasthra account for the largest number of pumpsets energised.[3] This was the direct result of the setting up of the Rural Electrification Corporation under the Fourth Five Year Plan following the recommendations of the All India Rural Credit Review Committee.[4]

Returning to Table II.7 we find that surface wells fitted with electric or diesel engines are suitable means of irrigation for the cultivation of HYV. Between the two, electric engines appear to be the more likely proposition given the difficulties caused by the international oil crisis.[5] The principal advantage in both cases is that both have smaller cultural command areas. As wells already exist in the district of West Godavary, the popularisation of these forms of irrigation merely involves

1 'Groundwater Resources for Irrigation in India,' op.cit., p 1509.

2 'Groundwater Resources for Irrigation in India,' op.cit., p 1509.

3 Iyer,K. 'Rural Electrification in India,' RBIB, XXXIII, 11, Nov. 1969, p 1742.

4 For the achievements of the Rural Electrification Corporation see, Anon, 'Sinews of Farm Revolution,' Commerce, CXX, 3092, Jan. 10, 1970; p 56, Anon, 'Energising Rural Areas,' Commerce, CXXI, 3092, Aug.8, 1970, p 284. The role of the Agricultural Refinance Corporation is also important here.

5 Farmers in Punjab are already facing considerable difficulties in obtaining diesel oil. Norman Borlang stated in March of this year that more than 1 million tons of wheat would be lost if Punjab farmers could not get oil soon. Anon, 'Oil Shortage a Threat to Indian Wheat,' Financial Times, 13.3.1974.

their energisation. The Irrigation Commission was of the opinion that surface wells should be exploited to the full to increase irrigation potential of the state.[1] From the table we also gather that per acre cost of irrigation by public tubewells is the lowest. We do not think that state tubewells are a suitable form of irrigation for the cultivation of HYV. Their unsuitability

Table II.8. Tubewells and Wells in West Godavary and Area Irrigated by them, 1965-66.

Tubewells		Wells		Total	Area
Government	Private	Government	Private		Irrigated (acres)
15	2107	529	6406	9057	9652

Source: Report of the Irrigation Commission, 1972, Vol. III, op.cit., (Part 2), p 145.

1 The total irrigation potential of the state from both major and minor irrigation projects is 4.12 m acres, the share of groundwater being 0.72 m acres or 17 per cent, Report of the Irrigation Commission, 1972, Vol. I, op.cit., p 218; also Vol. III (Part 2) p 146.

is due to their technical capacity of tubewells compared to private tubewells. State tubewells operate more closely to engineering capacity and can irrigate a larger acreage than private tubewells in order to reduce per acre cost of irrigation and to provide revenue to the state exchequer.[1] Increased utilisation, however, leads to frequent breakdown of machinery and consequent reduction in irrigated areas. Frequent operating failures detract from the flexibility of tubewells, a characteristic that lends itself to controlled irrigation.[2] The ability to provide assured water supply is also endangered. These problems are academic in West Godavary as state tubewells are few in number and constitute only 1 per cent of the total number of tubewells as indicated by the figures in Table II.8.

1 The revenue derived by the state depends upon the length of working hours and the rate charged per unit of irrigation water. The Programme Evaluation Organisation observed that state tubewells in all states are running at a loss, Study of the Problems of Minor Irrigation, op.cit., p 138.

2 The dilemma states face in this regard is described by Mellor,J.W. and Murthy,T.V. 'Dilemma of State Tubewells,' EPW, VI, 13, Mar. 27, 1971, pp A37-A44. Basing their study on a sample of 141 farms in the Aligarh district of Uttar Pradesh in 1966-67, they show how that in order to avert financial losses, state tubewells have to function at maximum capacity and this leads to frequent failures leading to high administrative and operational costs. By contrast, private tubewells are more reliable sources of water supply and farms irrigated by them enjoyed higher yields and higher gross returns than those depending on state tubewells. On the basis of their findings they concluded that private tubewells are superior to state tubewells for the cultivation of HYV.

II.4. Micro-analysis of Feasibility of Tubewells and Wells

The first step in the analysis is to show the economic advantages of tubewell irrigation. Our study follows closely the analysis of the problem by the Reserve Bank of India.[1] It is a modified cost-benefit approach. The aim of feasibility studies as evolved by the Reserve Bank of India is to estimate the incremental farm income that farms of different sizes are likely to obtain and to examine whether the increased income will be sufficient to repay loans taken from Land Mortgage Banks to invest in such projects.[2] Projects are appraised under this method in terms of the effect of investment on farm incomes alone and do not consider secondary benefits. Investment in tubewells is considered feasible if loans taken to finance them can be repaid. As feasibility studies were undertaken by the Reserve Bank in order to impress upon lending agencies the self-liquidating character of loans, the criterion of economic feasibility is essentially a limited one.[3] It is in this sense that the method of micro-analysis of feasibility differs from the usual cost-benefit analysis. Although in the assessment of benefits, the differences between the two approaches is a matter of coverage alone, in the estimation of annual capital costs the two approaches use entirely different methods.

1 Reserve Bank of India, Bank Credit for Farmers for Irrigation Development - Studies in Micro-analysis of Feasibility, Bombay 1969.

2 Central Cooperative Banks and Land Mortgage Banks are the chief sources of credit for investment in tubewells. In this connection it must be mentioned that there is considerable overlap between medium and long term loans for irrigation purposes, Reserve Bank of India, Studies in Agricultural Credit, Bombay 1970, p 97.

3 The concept of economic feasibility in relation to farm investment and some empirical applications of it are contained in a paper prepared by Jhakhade,V.M. and M.V. Gadgil, of the Division of Rural Surveys, Reserve Bank of India, entitled 'Production-and-Repayment-Capacity Oriented Landing for Farm Investment,' RBIB, XXIV, 1, Jan. 1970, pp 56-77.

In cost-benefit studies annual capital cost (including the rate of interest) of an investment is calculated with respect to the physical life-time of the asset. Under the micro approach, however, the annual capital charge is calculated in relation to the repayment period of the loan taken from banks. Thus the annual capital charge is the amount of equal annual repayments due plus the rate of interest.[1] This means that the lending policy of banks have a very important effect upon the feasibility of projects. Land Mortgage Banks cannot lend for periods exceeding 10 years on account of the maturity structure of their own borrowed resources.[2] The reference to the duration of loans means that a higher rate of amortisation of capital is applied in the calculation of annual capital charges and this means that the feasibility criterion is a more severe test of the economic viability of investment projects.

As investment in irrigation projects is bound to increase annual current costs by way of additional consumption of seeds, fertilisers, hired labour, etc. have also to be taken into account. Gross farm income from investment must be sufficient to cover annual capital charges plus increases in current expenses. Symbolically, the criterion of feasibility adopted in these studies can be expressed as:

$$Y \geqq Q + C$$

where Y stands for gross income, C represents annual current consumption. Q is the annual capital charge calculated with respect to the repayment period of the loan and the rate of interest.[3] Proposals for loans must satisfy this test in order to be judged feasible.

1 In the case of investment in tubewells and wells, repayment falls due only during the second year of the project.

2 Jakhade and Gadgil, op.cit., p 57; see also All-India Rural Credit Review Committee, op.cit., p 823.

3 For their feasibility studies Jakhade and Gadgil, op.cit., have an additional term "K" on the right-hand side of the equation. It is a catch-all term acting as a cushion to absorb the impact of rice in consumption expenditure, adverse turns in weather conditions and price-cost relations. As the term is more important in the measure of overall repayment capacity, it has been ignored in our study.

The Reserve Bank Study dealt with the districts of Patiala, Kapurthala and Ludhiana in Punjab. As no time series data was available for projecting increases in farm income and cost after the construction of tubewells, the estimates were derived by a comparison of the farm income structures of owners and non-owners of tubewells. The expectation was that when non-owners construct tubewells, then all aspects of the farm enterprise such as income, expenditure, cropping pattern, intensity of irrigation, etc. will approximate those of tubewell owners.[1] The main findings of the study were that the construction of tubewells gave rise to additional gross income, which was adequate to repay loans taken from Land Mortgage Banks. Net income was positive and all projects submitted to the Refinance Corporation were economically feasible.

The aims of our study of tubewell irrigation on our sample farms are similar to those of the feasibility study described above. They are to estimate the incremental farm income that farms of different sizes are likely to obtain as a result of investing in tubewells and wells and to examine whether the incremental income is sufficient to repay loans taken for installing them. A case is then made for the relative superiority of wells. The methodology followed in calculating net additional income and repayment capacity is the same in both cases. Where the two differ is that whereas the Reserve Bank of India study is based on farm structures of actual owners and non-owners of tubewells, ours is based on actual non-owners and hypothetical owners of tubewells and wells. The hypothetical owner being defined as one on whose farm the maximum potential yield of the variety is achieved.[2]

1 Bank Credit for Irrigation Development-Studies in Micro-analysis of Feasibility, op.cit., pp 110,135,156.

2 This is perhaps the weakest link in the analysis. Short of actual data on the effects of tubewell irrigation on farms in West Godavary, this seems to be the best we can do.

Tubewells/wells give rise to additional incomes on farms by making possible one or more of the following changes, a rise in the proportion of irrigated area,[1] an increase in the intensity of cropping[2] and a change in cropping pattern and/or an increase in yield per acre. As a consideration of all these factors will make the analysis very complicated, not to speak of the demands made on data, only primary benefits in terms of the value of additional yield made possible by controlled irrigation is taken into account. It is here that our assumption of the hypothetical owner comes into its own. We assume that the actual present yields on farms is not the maximum obtainable owing to the unsuitability of the existing system of irrigation for the controlled application of water. The maximum obtainable yield is taken to be that which is secured on experimental farms. These yields are obtained, after all, by those very water management practices which tubewells and electrified wells make possible. As a result of investment in tubewells and electrified wells, yield per acre is assumed to increase by 100 per cent on farms irrespective of size.

1 This possibility can be discounted right away because all farms in our sample are fully irrigated, see Appendix Tables VII and IX for details.

2 By intensity of cropping is meant the ratio of gross cropped area to net cultivated are multiplied by one hundred, Directorate of Economies & Statistics, Ministry of Food & Agriculture, Community Development & Cooperation, Construction of Agricultural Index Numbers in India, (Report of the Technical Committee), New Delhi, 1967, p 16.

Gross income in the post-tubewell/well period[1] has been obtained by multiplying the estimated yield on farms by the weighted average of harvest prices by size class of farms. Estimates of gross income before and after installing tubewells/wells are given in Table II.9, Columns 2 & 5 respectively. It is assumed that gross incomes from investment in both tubewells and wells are the same.

Project costs including costs of maintenance have been calculated in relation to the lending policy of Land Mortgage Banks in Andhra Pradesh.[2] The Land Mortgage Banks in West Godavary give loans for constructing tubewells upto 50 per cent of the value of mortgaged land. This policy along with the duration of the repayment period has a bearing upon the eligibility of farms of different sizes to acquire loans. The nature of the lending policy of Land Mortgage Banks is spelt out in order to show how small farmers are automatically disqualified from acquiring loans.

Land is generally valued according to two prices in Andhra Pradesh. The open market price and that offered by the Land Mortgage Banks. The market price is usually based on the cultivator's valuation of land and is normally based on a three year sales statistics of land transactions. It is higher than the price offered by the Land Mortgage Banks.[3]

1 This monstrous expression refers to the situation on the farms after the installation of tubewells or wells.

2 The method of calculating project costs has already been discussed, refer p 98 above.

3 The price offered by Land Mortgage Banks like the one offered by the Government is only a quarter of the market price, Studies in Agricultural Credit, op.cit., p 166.

Table II.9. Net Income Before and After Installing Tubewells/Wells in West Godavary, Kharif & Rabi, 1968-69

	PRE-TUBEWELL PERIOD			POST-TUBEWELL PERIOD				Rs
	Gross Income per Acre Y	Total Cost per Acre C	Net Income per Acre (Y-C)	Gross Income per Acre ΔY	Total Cost per Acre ΔC	Net Income per Acre $\Delta Y - \Delta C$	Additional Net Income per Acre $(\Delta Y-\Delta C)-(Y-C)$	Additional Net Income per Farm
1	2	3	4	5	6	7	8	9
Kharif								
Below 5.00	1122.47	406.62	715.85	2379.12	609.93	1719.19	1003.34	3351.12
5.01 - 10.00	469.69	399.91	119.78	1749.50	599.87	1149.63	1029.85	7075.51
10.01 - 15.00	1243.66	419.51	824.15	2105.06	629.27	1475.79	651.64	7878.33
15.01 - 20.00	1034.32	303.29	731.03	2134.09	454.94	1679.15	948.12	16430.92
20.01 & Above	903.87	405.92	497.95	1835.30	608.88	1226.42	828.47	32426.32
Rabi								
Below 5.00	1057.01	477.46	549.55	2225.30	795.67	1429.63	880.08	2270.61
5.01 - 10.00	1020.10	548.38	471.72	2146.09	913.97	1232.12	760.40	5307.59
10.01 - 15.00	1521.74	561.54	960.20	1999.26	935.90	1063.36	103.16	1345.21
15.01 - 20.00	1008.67	680.02	328.65	2655.74	1133.57	1522.37	1193.72	51418.89
20.01 & Above	1314.62	626.63	687.99	2625.95	1044.38	1581.57	893.58	21535.28

Source: Columns 2 & 3, Appendix Table VII, Column 9, Appendix Table V. All other computations are based on Columns 2 & 3.

The price used for calculating the value of land for our purposes is that offered by the Ellore Cooperative Land Mortgage Bank which is Rs 3000 per acre of irrigated land.[1] The valuation of owned land[2] at this price[3] according to the different farm sizes is given in Table II.10.

Table II.10 Valuation of Land, West Godavary, Kharif & Rabi, 1968/69

Size Group of Farms	Average Size of Farm (acres)		Value of Land at Rs 3000 per acre	
	Kharif	Rabi	Kharif	Rabi
1	2	3	4	5
0.01 - 5.00	3.34	2.58	10020.00	7740.00
5.01 - 10.00	6.87	6.98	20610.00	20940.00
10.01 - 15.00	12.09	13.04	36270.00	39120.00
15.01 - 20.00	17.33	16.10	51990.00	48300.00
20.01 & Above	39.14	24.10	117420.00	72300.00
All Sizes	19.29	7.48	57870.00	22440.00

Source: Frankel, F.F. India's Green Revolution - Economic Gains and Political Costs, op.cit., p 59; Appendix Table V.

Note: Price of land per acre refers to the period 1965-66 to 1968-69.

1 The price is based on a seven year sales statistics of land transactions, Frankel, op.cit., p 59.

2 The whole argument is based on the assumption that the farmers are in a position to mortgage their land. While this may be true of large farms it is unlikely to be so in the case of small farms. Data on the extent of land mortgaged shows that if anything the latter are mortgaged to the hilt, Studies in Agricultural Credit, op.cit., p 166.

3 The price offered by the Land Mortgage Banks is very much lower than the market price of land being only a quarter of the latter. The Reserve Bank of India notes that the eligibility of farms for loans from LMBs can be increased considerably by a more realistic valuation of land, ibid., p 166.

As tubewells cost Rs 10,000 and Land Mortgage Banks give loans amounting to only 50 per cent of the value of mortgaged land, Table II.10 shows that farms below 10 acres cannot invest in tubewells. We can find corroboration of this by looking at the actual lending policies of Land Mortgage Banks in Andhra Pradesh. In the district of Ellore in the state 60 per cent of the loans went to farmers with 10 to 15 acres of land.[1] The Programme Evaluation Organisation also observed a similar phenomenon. It noted that 43 per cent of farmers owning tubewells had land above 8 acres in size and such farms also accounted for 61 per cent of the ownership of pumpsets.[2] Another significant fact observed by the Programme Evaluation Commission was that 71 per cent of total expenditure on tubewells was financed by own funds. Taking expenditure on minor irrigation as a whole, 60 per cent was financed by own funds, 30 per cent by cooperative and departmental agencies and the balance by private sources. In West Godavary, especially in the prosperous Deltaic regions, the purchase of tubewells was financed by own funds on 10-acre farms.[3]

This brief digression on the consequences of security-based lending by Land Mortgage Banks will enable us to throw into greater relief the alternative basis for medium term lending namely, production potential on farms. Our aim is to show that increased gross income on farms after investment in tubewells/wells is sufficient to redeem annual capital charges and increased cultivation expenses. What is more, loans made on the basis of production potential will give all sizes of farms a comparable opportunity in having access to water supplies. Throughout, the relative merits of tubewells and wells will be borne in mind.

1 Frankel, India's Green Revolution - Economic Gains and Political Costs, op.cit., pp 49-50.

2 Government of India, Planning Commission, Report on the Evaluation of Higher Yielding Varieties Programme, Kharif, 1968, p 59. Although detailed figures are given on the expenditure on tubewells and pumpsets according to size class of farms, they have to be used with great caution on account of several arithmetical errors.

3 Frankel, India's Green Revolution and Economic Gains and Political Costs, op.cit., p 59.

On page 102 we gave estimates of gross income after the installation of tubewells/wells on our sample farms.[1] The costs of investment can be divided into current costs and capital costs. The latter is the cost of investment itself and the rate of interest. To determine the economic feasibility of investment in wells and tubewells, capital costs have to be converted into an annual charge. For calculating annual capital charges we take the price of a tubewell and a well to be Rs 10,000 and Rs 4,000 respectively. The rate of interest and the repayment period for loans not being available for West Godavary, those for the district in Krishna in Andhra Pradesh have been used. The rates of interest used are $8\frac{1}{2}$ per cent for loans for tubewells and 9 per cent for wells.[2] The repayment period for these two types of loans are 10 years and 13 years respectively.[3] The equated annual capital charge for a tubewell works out to be Rs 1583.43 and that for a well is Rs 2,270. These charges are taken to be the same for both seasons.

1 We ignore, here, receipts from the sale of water.

2 Nothing is lost by this approximation as institutional credit is made available to agriculturists at rates ranging from $6\frac{1}{2}$ per cent to 12 per cent per annum, Kanvinde,D.J. 'Rural Markets for Bank Deposits - Main Features,' State Bank of India Monthly Review, VIII, 12, Dec. 1969, pp 409-422. The rates of interest on medium term loans given to individuals by Land Mortgage Banks is not recorded in the Statistical Statements Relating to the Cooperative Movement in India, 1970-71, Part I, Credit Societies (Reserve Bank of India), see p 160.

3 Studies in Agricultural Credit, op.cit., p 193; see also, Varadachary,T.R.V. 'State Bank Assists Green Revolution,' State Bank of India Monthly Review, VIII, 3, March 1969, p 94.

Turning now to the calculation of annual current costs of production, owing to the limitations of data we take into account only increases in the overall increases in cost of producing HYV in the two seasons. These have been derived by applying input-output ratios of 1:1.99 and 1:1.50 in the Kharif and the Rabi season respectively.[1] As we have assumed a 100 per cent increase in yield in both seasons we can assume total cost of production to increase in the Kharif season by 50 per cent and in the Rabi season by 66 per cent. The total cost of cultivating IR-8 before and after the installation of tube-wells/wells is shown in Table II.9., Columns 3 & 6. The net additional income is shown in columns per acre and per acre and per farm in Columns 8 & 9 respectively. Feasibility of investment in tubewells and wells can be determined by comparing the net additional income and annual capital charges. These are shown in Table II.11.

1 Report for Kharif, op.cit., p 50 and Report for Rabi, p 90. Although the latter report refers to an input-output ratio of 1:1.62 we have rounded it down to 1:1.50.

2 Net additional income is the difference in net income before and after the construction of tubewells and wells. In terms of our formula for feasibility (refer p98 above), we have merely transposed C to the left-hand side giving us the equation, $Y - C = Q$.

Table II.11 Net Additional Income per Farm and Annual Capital Charges relating to Tubewells and Wells, West Godavary, Kharif and Rabi, 1968-69.

	Net Additional Income per Farm from Construction of Tubewell/well $(\Delta Y-\Delta C)-(Y-C)$	Annual Capital Charge or Loan Required for Investment in Tubewell Q_T	Annual Capital Charge for Loan required for Investment in Wells Q_W
1	2	3	4
Kharif			
Below 5.00	3351.12	1583.43	2270.00
5.01 - 10.00	7075.51	1583.43	2270.00
10.01 - 15.00	7878.33	1583.43	2270.00
15.01 - 20.00	16430.92	1583.43	2270.00
20.01 & Above	32426.32	1583.43	2270.00
Rabi			
Below 5.00	2270.61	1583.43	2270.00
5.01 - 10.00	5307.59	1583.43	2270.00
10.01 - 15.00	1345.21	1583.43	2270.00
15.02 - 20.00	51418.89	1583.43	2270.00
20.01 & Above	21535.28	1583.43	2270.00

Source: Column 2, Table II.9, Column 9; Columns 3 & 4, see page 105 above.

Note: Annual capital charge indicates the equated annual repayment due on the actual cost of investment in tubewell/well. The period of repayment assumed is 10 years and 3 years for tubewell and well respectively. The rate of interest is $8\frac{1}{2}$ per cent per annum for tubewells and 9 per cent for well.

From a comparison of Tables II.10 and II.11 we gather that farms disqualified from acquiring loans from Land Mortgage Banks on the basis of security of land are able to get them on the basis of the criterion of feasibility as investments by them in tubewells/wells is self-liquidating. Also, net income per farm from the construction of tubewells/wells is adequate to repay the loans taken. The higher annual capital charge of wells compared to tubewells is due to the shorter repayment period for wells. Extension of this period will lower the annual charge leaving a larger balance after repayment. In this event, other things being equal, wells will be the cheaper of the two forms of irrigation for higher-yielding varieties of rice.

Implicit in the above conclusions are three basic assumptions: (1) the additional income expected from the proposed investment can be set aside for repayment, (2) farmers are able to stabilise their consumption and other expenditure at levels existing before the investment took place, and (3) there are no pre-existing liabilities.

The relaxation of these assumptions will involve going beyond the impact of tubewells/wells on farm income. It will require an assessment of the repayment capacity of borrowers in relation to the farm household as a whole. As this is beyond the scope of this section the above assumptions are maintained. Our figures do suggest, however, that even if we assume only half the net additional income will be used for repayment, except for farms below 10 acres, investment in tubewells/wells on farms in the sample will still be feasible according to the criterion adopted.

In order to buttress the results of our feasibility analysis, an attempt was made to show the potential comparative advantage of tubewells and wells by means of simple cost-benefit ratios. These are presented in Table II.12. The ratios show very little inter-farm differences between seasons. Cost-benefit ratios for tubewells are in general higher for tubewells than for wells. Differences in the ratios between seasons are

Table II.12 Cost-Benefit Ratios for Tubewells and Wells, West Godavary, Kharif and Rabi, 1968-69

Farm Size/Season (acres)	Tubewells	Wells
Kharif		
Below 5.00	1.06	0.81
5.01 - 10.00	0.80	0.61
10.01 - 15.00	0.94	0.73
15.01 - 20.00	1.05	0.78
20.00 & Above	0.84	0.64
Rabi		
Below 5.00	0.94	0.73
5.01 - 10.00	0.86	0.67
10.01 - 15.00	0.79	0.62
15.01 - 20.00	0.98	0.78
20.00 & Above	1.00	0.79

Source: Based on Tables II.9 and II.11

significant. The higher ratios for Kharif may be taken as reflecting the potential gains from the adoption of controlled means of irrigation in a season where the supply of water cannot be regulated under a system of canal irrigation.

Conclusion

The importance of irrigation in the cultivation of HYV arises from the fact that the yield potential of these varieties can only be realised with high levels of fertiliser and careful application of water. From an examination of the actual water requirements of the new varieties and of the nature of the existing system of canal irrigation in Andhra Pradesh, we found that the latter is unsuitable as a method of controlled irrigation. This was traced to both technical and organisational factors. This led us to a consideration of tubewells and surface wells as alternative systems of irrigation. Basing our investigation on a modified cost-benefit approach, we found, that of the two systems, surface wells energised with electric pumps were a more suitable form of irrigation for the cultivation of HYV on our sample farms.

CHAPTER THREE

FERTILISERS

Fertilisers play an important role in agricultural production as the opportunity to bring new land under cultivation declines.[1] Sustained increases in yield per acre require increasing application of fertilisers, especially if the time interval taken between crops is short. Unless nutrients are supplied to the soil, yields will decline when the natural fertility of the soil is depleted. The more intensely the land is cultivated or the poorer the soil at the beginning, the sooner this will occur.

Fertilisers have been subjected to extensive economic analysis, both as a substitute for land and as a form of capital investment.[2] Owing to their divisibility they lend themselves to production function analysis and optimising criteria. Unlike land and labour inputs, which are endogenous to the agricultural sector, fertilisers constitute a neat type of resource whose introduction in the cultivation of crops can be regarded as an innovation that shifts the production function exogenously. The complementarity between fertilisers and irrigation has already been explored in Chapter Two. Although the consumption of fertilisers increased several-fold during the last decade in countries like the

1 Broadly speaking, fertiliser is any material, organic or inorganic, natural or synthetic that furnishes to plants one or more of the chemical elements needed for growth. Unless otherwise stated, all reference is to chemical fertilisers. Technical information on fertilisers has been obtained from United Nations, Industrial Development Organisation, Fertiliser Manual, New York, 1967, Chapter I, pp 40-46.

2 It is estimated that in India, a ton of nitrogen will produce approximately the same quantity of total output, at prevailing levels of yield as 5 acres of unmanured paddy, Kanwar, J.S. 'Fertiliser - the King-pin in Agriculture,' IF, XVIII, 12, Mar. 1969, pp 5-6.

USA, the marginal return from investment in this input continues to be higher than in any other type of input.[1]

The importance of fertilisers in relation to the new varieties derives from both the physical requirements of these varieties and the poor quality of Indian soils. The new varieties have been specially evolved to tolerate high fertiliser dressings.[2] In the Model Agronomic experiments it was observed that IR-8 gave yields of 1193 and 1616 kgs per acre at 54 and 187 kgs per acre of N respectively, compared to 354 and 299 kgs per acre for similar dosages of N in the case of tall <u>indica</u> varieties.[3] The six-fold increase in yield (approximately) when the dosage of N is increased from 54 kgs per acre to 107 kgs per acre is due to the fact that IR-8, like the other new varieties uses N more efficiently, <u>cet.par.</u>[4] At high levels of fertiliser application the tall varieties tend to lodge.[5] The non-responsiveness of the tall varieties

1 In the USA, the marginal product-unit cost ratio for fertilisers was 2.4, 3.0 and 2.5 times as high as that for labour, land and machinery and buildings respectively in 1969, Sahota,G.S. <u>Fertilisers in Relation to Economic Development</u>, Praeger Special Studies in International Economic Development, London, 1968, p ix.

2 Seetharaman,P. 'New Plant Types in Relation to Higher Production,' <u>IF</u>, XVI, 6, Sept. 1967 (Special Rice Number), pp 42-45.

3 Indian Council of Agricultural Research, <u>Annual Report</u>, <u>1967-68</u>, <u>op.cit.</u>, p 51.

4 <u>Ibid</u>. Comparing the yield response of IR-8 and other tall varieties in terms of grain-yield kilogramme of N applied, we notice once again the superior performance of the former. When N was applied at 54 kgs per acre, IR-8 gave an additional yield of 22 kgs of grain per kg of N, whereas, the tall varieties yielded only 6.6 kgs per kg of N. The difference to the yield-response of the two varieties is highlighted even further when we compare their relative performance at a higher level of fertiliser application. At 107 kgs per acre, IR-8 yielded 8 kilogramme of grain per kg of N, while the yield of the tall varieties was only 1 kg of grain per kg of N, <u>ibid</u>. This comparison of the yield response of the two varieties is useful in showing how, if we increase levels of fertiliser application in the case of IR-8, diminishing returns set in.

5 The non-responsiveness of tall varieties was demonstrated in a study of yield-responsiveness of rice to nitrogen in India and the USA; see Herdt, R.W. & Mellor,J.W. 'The Contrasting Response of Rice to Nitrogen: India and the US,' <u>Journal of Farm Economics</u>, XLVI, 1, Feb. 1964, pp 150-160.

to high doses of N is perhaps reflected in the use pattern of fertilisers in India during 1954-55 and 1963-64. Mellor and Desai found that the chief source of growth in fertiliser use during this period was the increase in area fertilised rather than increase in levels of application.[1]

The higher the fertiliser response of the new varieties, the greater the rate of removal of nutrients from the soil. The situation is all the more serious when we consider that all soils in India require additional doses of nitrogen, phosphorous and potash if yields are to be raised by 50 to 100 per cent.[2] All rice varieties make demands on all three major nutrients. While nitrogen is the universal requirement, the absence of phosphoric acid can be a limiting factor as the former has to be combined with the latter for best results. The need for potash is much less and is pronounced only in some areas.[3]

In this chapter we examine the factors which determine the demand for fertilisers at the micro-level, Section III.1. Fertiliser prices are discussed in Section III.2; high fertiliser prices are traced to problems facing the fertiliser industry in India. Section III.3 examines problems relating to the supply and distribution of fertilisers in Andhra Pradesh. The chapter ends with a statement of the principal conclusions.

1 Mellor,J.W. & Desai,G.M. 'Changing Basis of Demand for Fertilisers,' EPW, IV, 39, Sept. 27, 1969, pp 175-187.

2 The poor quality of soils in India was revealed by soil tests conducted all over the country, Agarwal,R.R. Soil Fertility in India, Asia Publishing House, London, 1965, p 12.

3 Mahapatra,I.C. 'Fertiliser Needs of Rice,' Indian Farming, XVIII, 12, Mar. 1969, p 21.

III.1. Demand for Fertilisers

The individual cultivator's demand for fertilisers depends upon the net returns from their use.[1] The economically optimum fertiliser dressing is that which maximises monetary returns from their use at the prevailing cost-price relationships between fertiliser input and paddy output. The profitable level of fertiliser use may be defined by the following equation where the term to the left of the equality

$$\frac{dY}{dF} = \frac{Pf}{Py}$$

is the marginal yield or response and the term to the right is the cost-price (price per unit of fertiliser divided by the price per unit of yield). The marginal yield is the derivative of yield with respect to any particular nutrient and is given by the slope of the response function.[2] The most profitable level of fertiliser use changes as the term on the right-hand side

1 The demand for fertilisers is measured in terms of the application of nutrient per acre of land in our analysis.

2 In the case of all varieties, the response of yield to fertilisers depends upon, the type of soil, the form of fertiliser used, etc. A number of functional models can describe this relationship. Investigations of the suitability of different functional models for Indian data showed that the simple quadratic curve gave by far the best result, Food and Agricultural Organisation of the United Nations, Statistics of Crop Responses to Fertilisers, Rome 1966, pp 5-8 and Appendix C, pp 89-103. Until recently, fertiliser-yield relationships in India were obtained from experiments carried out in experimental stations. Now these are obtained from fertiliser trials on farmers' fields, Panse,V.G. and Abraham,T.P. 'Fertiliser Response in Relation to Rice Yields,' IF, XVI, 6, 1966, Special Rice Number, pp 58, 138-139 & 158; Singh,D. Rajeha,S.K. & Bapat,S.R. 'Returns from Fertilisers on Farmers' Fields,' IJAE, XV, 3, July-Sept. 1970, pp 25-39.

of the equation changes.[1] Assuming a nitrogen-paddy price ratio of 5:1,[2] Herdt calculated the response of local and IR-8 varieties of rice for Kharif and Rabi using the results of experiments conducted by the All-India Co-ordinated Rice Improvement Programme in 1968.[3] These are shown in Table III.1.

Table III.1. Yield Response of IR-8 and Traditional Varieties, Kharif & Rabi, 1968

	Rabi		Kharif	
	Optimal Dose of N lb/a	Yield lb/a	Optimal Dose of N lb/a	Yield lb/a
IR-8	173	6639	122	4559
Local	96	4185	96	3561

Source: Herdt,R.W. 'Nitrogen Response of Rice: 1968 AICRIP Trials,' EPW, VI, 13, Mar. 27, 1971, pp A33-A36.

Note: The figures refer to All-India.

The table helps to show not only that IR-8 tolerates higher levels of N but also the fact that between seasons, yield response to N was greater during Rabi than Kharif.

1 How much change has to be made to fertiliser use as a result of change in prices depends upon the slope of the response function. If the slope increases only slowly over a wide range of fertiliser inputs and the price ratio increases then losses from not altering levels of fertiliser use will be greater than if the slope increased greatly over a small range of fertilisers.

2 Herdt,R.W. 'Nitrogen Response of Rice: 1968 AICRIP Trials,' EPW, VI, 13, Mar. 27 1971, pp A33-A36. The prices of paddy and N were respectively Rs 50/q and Rs 250/q.

3 The AICRIP 1968 trials were conducted in 20 locations during Kharif and 11 locations in Rabi, Herdt,R.W. 'Profitability of High-Yielding Wheat and Rice,' EPW, IV, 52, Dec. 1969, pp A197-A203. The AICRIP was launched in 1965 by different rice breeders as a hybridisation Programme, see Shastry,S.V.S. 'High-Yielding Varieties of Rice,' IF, XVIII, 11, Feb. 1969, pp 5-13.

Although a knowledge of response functions is vital for the successful cultivation of IR-8 like other high-yielding varieties and forms the basis of recommendations of fertiliser dressings made to farmers by extension agencies and agricultural departments, the actual levels of fertilisers used by them will depend upon their attitude towards risk and uncertainty. The nature and the magnitude of the divergence between recommended and actual doses of fertilisers in Andhra Pradesh will be discussed later on. First we shall try to illustrate how the overall effect of risk and uncertainty is to reduce the optimum dose of fertiliser and net profit incidental to their use.

It is difficult to make precise estimates of uncertainties arising from either the variability of the weather or from the incidence of pests and disease. Approaches to the problem vary. Allowance is made for them when evaluating mean response to fertiliser application. For instance, the FAO in its study Statistics of Crop Response to Fertilisers assumes discounts of nearly 20 per cent of average yield.[1] Alternatively, a price discount is assumed. Using the results of the AICRIP Trials for 1968, Herdt calculated the profitability of IR-8 by assuming a price discount of 20 per cent.[2] We present first the results of the FAO study, for, the results of the Southern Agro-Climatic region typifies the situation in Andhra Pradesh. The calculations made by Herdt, although they refer to All-India are by far the best estimates we have regarding the profitability of IR-8 vis-à-vis local varieties assuming price discounts.

1 Statistics of Crop Response to Fertilisers, op.cit., pp 31-33. The FAO results are based on response curves fitted to yield data from 5,370 trials on cultivators' fields in different rice zones in India over a period of 3-5 years.

2 Herdt, R.W. 'Nitrogen Response of Rice: AICRIP 1968 Trials,' op.cit., p A34.

Table III.2. Optimum Fertiliser Dose and Economics of Fertiliser Use Rice Crop, Southern Region

Optimum Dose kg/a N	Response to Optimum Dose kg/a	Net Profit Rs/a	Profit on Investment %
1	2	3	4
75.57	726.82	123.39	193
67.75	695.53	76.64	115

Source: Statistics of Crop Response to Fertilisers, op.cit., pp 32-33.

Note: For purposes of the FAO study India was divided into four agro-climatic regions of which the Southern region comprising the state of Andhra Pradesh is one.

The FAO calculated the optimum dose of N and net profit incidental to its use by assuming the price of rice to be Rs 0.57 per kg of paddy and Rs 1.87 per kg of N. Referring to Table III.2, in the calculation of figures in the first row no allowance is made for risk and uncertainty. The figures in the second row reflect a discount for risk and uncertainty equal to 20 per cent of yield response. Also included in total cost of using fertilisers is the cost of applying fertilisers - per acre cost here being Rs 2.42. A comparison of the figures in both rows shows how, by allowing for risk and uncertainty and costs accompanying the application of fertilisers, both the optimum dose of fertilisers and net profits are lowered considerably. Similarly, the profit from investment in fertilisers (Column 4) is also lowered once we take into account uncertainty.[1]

1 Profit on investment was calculated by assuming a rate of interest of 12 per cent p.a.

Table III.3. Profitability of IR-8 and Traditional Varieties, All-India, 1968-69

	Rabi		Kharif	
	No Discount	At 20% Discount	No Discount	At 20% Discount
Net Returns to Fertilisers				
IR-8 (Rs/a)	584.18	445.21	303.40	186.24
Local (Rs/a)	219.78	219.78	216.54	216.54
Rate of Return on Fertilisers				
IR-8 (%)	735	563	445	331
Local (%)	476	476	365	365

Source: Herdt,R.W. 'Nitrogen Response of Rice: AICRIP 1968 Trials,' op.cit., p A34.

In calculating the figures in Table III.3, Herdt assumed a nitrogen-paddy price ratio of 5:1. Net return was calculated by finding the gross value of production at the optimum rate of fertiliser application and deducting both the value of production at zero fertiliser level and value of fertiliser applied. The rate of return on fertiliser was obtained by dividing the net return to fertiliser by the cost of fertiliser applied. From the table we gather that net return from fertiliser without allowing for risk and uncertainty[1] is more than double that of traditional varieties in the case of IR-8. Allowing for risk and uncertainty, however, the superiority of IR-8 in this regard holds only in the Rabi season.[2] The rate of return on fertiliser follows a similar pattern.

1 Risk and uncertainty here refers to variation in future rice prices. A price discount was assumed for IR-8 only.

2 This may be partly due to the superior yield of rice in the Rabi season.

From the foregoing discussion we see that, theoretically, the demand for fertilisers is determined by the profitability of using fertilisers. It is not possible to determine the demand for fertiliser on the basis of profitability on our sample farms owing to the lack of adequate data for calculating the yield response ratios on farms of different sizes and the cost-price ratio. Although response ratios for IR-8 are available and these have already been referred to, these have been obtained on the basis of highly aggregated data.[1] We do not know whether they reflect adequately yield responses to fertilisers on our sample farms. Calculation of the cost-price ratio also presents problems because of the method of financing the purchase of fertilisers. Nearly 50 per cent of the expenditure on fertilisers is financed by credit.[2] Calculation of the magnitudes involved in the concept of profitability being difficult, no attempt is made by us to determine demand schedules for our sample farms on the basis of profitability. Even the World Bank in its study of the effective demand for fertilisers in India concluded that attempts to use crop-response ratios as a guide to the calculation of economically optimum rates and then projecting district-wise demand as having

1 Hopper's yardsticks for fertilisers and irrigation are an useful example, Hopper, W.D. 'Planning Yardsticks for Fertilisers and Irrigation,' op.cit., pp 175-187. For a critique of aggregative yardsticks, see Ishikawa, S. Economic Development in Asian Perspective, op.cit., pp 158-159.

2 Refer section on supply and distribution of fertiliser for an elaboration of this point, Section III.3. The calculation of cost-price ratios will depend upon the type of fertiliser used and whether reference is to the minimum guaranteed price of paddy or the procurement price. The Ministry of Food and Agriculture estimated the relative cost-price ratio in terms of the quintals of rice required to buy one quintal of fertiliser in Andhra Pradesh in 1967:

N	P_2O_5	K_2O
3.01	3.21	0.96

The price assumed for N is the retail price of the Sulphate of Ammonia, that of P_2O_5, the retail price of single superphosphate and that of K_2O, the retail price of the Muriate of potash. The price for rice refers to the controlled price for common varieties, Agricultural Reforms Commission, Report of the Study Team on Agricultural Administration, September 1967, Vol. I & II, New Delhi, 1969, Annexure XV(H), iii, p 835.

only limited usefulness on account of the highly restrictive assumptions that have to be made.[1] Ishikawa has also shown on the basis of an international comparison of the profitability of fertiliser use that a large number of variables of an exogenous and endogenous nature affect a farmer's decision to use a particular level of fertiliser.[2] These variables include the availability of credit and the associated costs of using fertilisers due to the complementarity between fertilisers and other inputs, especially irrigation. Thus the factors determining the use of fertilisers on our sample farms can be identified by looking at the actual trends in the consumption of fertilisers and the investigation of the reasons for the divergence between the actual and recommended doses of fertilisers. The latter aspect is important because of the complementarity in the use of the various inputs in the cultivation of the new varieties. We address ourselves therefore to the study of these aspects.

Table III.4 shows the changes in consumption of N, P and K over the period 1960-61 and 1969-70 in West Godavary. Barring the year 1965-66 which was a drought year, there was a steady increase in the total consumption of N as shown by the index of growth and consumption of N per acre.

1 International Bank for Reconstruction and Development, International Development Association, Effective Demand for Fertilisers in India, A Joint Study with the Government of India, March 27, 1972, pp 10-11.

2 Ishikawa,S. Economic Development in Asian Perspective, op.cit., pp 153-187.

Table III.4. Consumption of Chemical Fertilisers in West Godavary, 1960-61 to 1969-70

Year	Nitrogenous fertilisers in terms of ammonium sulphate (tonnes)		Phosphatic fertilisers in terms of super phosphate (tonnes)		Potash fertilisers in terms of murate of potash (tonnes)		Area under Paddy '000 acres	Consumption of Nitrogen kg/a
	Actual	Index	Actual	Index	Actual	Index		
1	2	3	4	5	6	7	8	8
1960-61	2,681	100.0	2,442	100.0	-	-	875	4.00
1961-62	15,351	572.6	13,383	548.0	346	100.0	928	17.00
1962-63	25,978	969.0	17,091	699.8	346	100.0	940	28.00
1963-64	46,819	1,746.3	20,465	838.0	636	183.8	907	52.00
1964-65	53,578	1,998.4	32,084	1,313.8	2,346	678.0	954	56.00
1965-66	48,034	1,791.6	48,290	1,977.4	1,000	289.0	916	52.00
1966-67	74,125	2,764.8	37,739	1,545.4	1,500	433.5	924	80.00
1967-68	94,086	3,509.3	39,608	1,621.9	1,810	523.1	957	98.00
1968-69	96,000	3,580.7	41,123	1,683.9	1,831	529.1	810	118.00
1969-70	98,422	3,671.0	43,250	1,771.0	2,100	606.9	690	142.00

Source: Columns 1 - 8, George,P.S. & Choukidar,V.V. Production & Marketing Pattern of Paddy, Indian Institute of Management, Ahmedabad, 1972, pp 26 & 246.
Column 9 - Computed from Columns 2 & 8.

Although the relative importance of the three main types of chemical fertilisers including their relative rates of growth during 1960-61 and 1969-70 is apparent from Table III.4, a closer look at the trends in the application of these fertilisers since 1966-67 reveals some finer details. Sample surveys carried out in the districts covered by the Intensive Agricultural Districts Programme for successive crop seasons between 1966-67 and 1968-69 showed that nitrogenous fertilisers were applied to over 90 per cent of area under HYV in West Godavary.[1] By contrast, nitrogenous fertilisers were applied to only 80 per cent of the area seeded to traditional varieties. Phosphatic fertilisers were applied to 50 per cent of the area under both varieties. Although potash was not applied on any significant scale in the cultivation of HYV, moderate doses of this fertiliser were applied in the cultivation of traditional varieties. Table III.5 gives the average rates of application of the three fertilisers and the percentage of farmers applying them. The table shows that the average rates of application of all three fertilisers was higher in the Rabi season than in the Kharif season for both varieties in all the three years.[2] The percentage of farmers using nitrogenous fertilisers was higher in the Rabi season for both varieties. Although the average rates of application of phosphatic fertilisers in the case of HYV was the same for the three years taking each season separately, its growing popularity can be detected from the higher proportion of farms using it.

1 Krishnan, K.S. & Mehrotra, P.C. 'Performance of High-Yielding Varieties of Rice in Cultivators' Fields in IADP districts,' <u>ASI</u>, XXV, 5, August 1970, pp 463-465. The data relate to 4459 crop-cutting experiments in the case of HYV and 4269 similar experiments for traditional varieties in the thirteen IADP districts.

2 The higher average rates of application of fertilisers in the Rabi season can be ascribed to the greater scope for controlled irrigation in this season.

Table III.5. Average Rates of Application of Different Types of Fertilisers, West Godavary, Kharif and Rabi 1966-67 to 1968-69

Crop Season	Year	Average Rates of Application kgs/a					
		HYV			Traditional		
		N	P_2O_5	K_2O	N	P_2O_5	K_2O
Kharif	1966-67	64.37(99)	34.87(72)	40.23(52)	18.77(73)	22.35(8)	-
	1967-68	68.84(98)	36.65(84)	37.55(20)	27.71(80)	21.46(19)	-
	1968-69	85.82(97)	36.65(89)	34.87(23)	25.03(67)	24.14(22)	-
Rabi	1966-67	80.46(100)	47.38(59)	- (0)	40.23(97)	40.23(51)	42.02(2)
	1967-68	110.86(100)	47.38(99)	40.23(35)	50.06(93)	28.61(74)	36.65(11)
	1968-69	109.07(100)	43.81(96)	39.34(42)	48.28(97)	32.18(67)	37.55(6)

Source: Krishnan, K.S. & Mehrotra, P.C. 'Performance of High-Yielding Varieties of Rice in Cultivators' Fields in IADP Districts,' ASI, XXV, 5, August 1970, pp 475-477.

Note: Figures in brackets refer to percentage of farms cultivating HYV and Traditional Varieties respectively.

The actual and recommended rates of application of the three major types of fertilisers used in West Godavary are shown in Table III.6.[1] The table is useful not only in showing the divergence between recommended and actual doses but brings into relief the importance of nitrogenous fertilisers. The actual rate of application of N exceeded the recommended dose in the case of HYV in both Kharif and Rabi season. In the cultivation of traditional varieties, the actual rate exceeded the recommended rate only in the Rabi season. The actual rate of application of phosphatic fertilisers in the cultivation of HYV was below the recommended dose in the Kharif season. In the Rabi season however, the actual dose exceeded the recommended dose. With regard to potash, in general, the actual rate was below the recommended rate.

Table III.6. Recommended and Actual Rates of Application of Fertilisers IR-8 and Traditional Varieties, West Godavary, 1968-69.

kgs/a

	IR-8						Traditional					
	Recommended Rate			Actual Rate of Application			Recommended Rate			Actual Rate of Application		
	N	P	K	N	P	K	N	P	K	N	P	K
<u>Kharif</u>	60	70	40	104.65	15.66	4.17	15-20	20	0	15.96	0.58	0
<u>Rabi</u>	100	30	15	146.22	62.96	0.21	30-40	30	30	94.27	60.45	1.94

Source: <u>Report for Kharif</u>, <u>op.cit.</u>, pp 36-37; <u>Report for Rabi</u>, <u>op.cit.</u>, p 39.

1 Fertilisers recommendations are made by both the Department of Agriculture, Andhra Pradesh and the Soil Testing Laboratory at Tadepalligudem, <u>Report for Kharif</u>, <u>op.cit.</u>, p 36.

Out of the total of 60 cultivators in our sample farms 56 cultivated IR-8 in the Kharif season. Of these only 72 per cent applied the minimum recommended dose of nitrogen. The percentage of cultivation applying minimum doses of P and K being 11 per cent and 2 per cent respectively.[1] No farmer applied the minimum recommended dose of all three fertilisers.[2] In the cultivation of traditional varieties, actual rates of application of fertilisers were nearer the recommended doses.[3] Of the 28 cultivators growing IR-8 during the Rabi season (total sample = 30) 82 per cent applied the minimum recommended dose of N and 93 per cent applied the minimum recommended dose of P.[4] The minimum recommended dose of K was not applied by any farmer. As in the Kharif season, no farmer applied the minimum dose of all three fertilisers.[5]

This comparison of the actual and recommended doses of the three important types of fertilisers shows the predominance of nitrogenous fertilisers.[6] In general, farmers preferred N to the other two types of fertiliser. An analysis of the use of the three different types according to farm size shows that in the Rabi season, large farms (above 10 acres) tended to use P and K more than small farms.[7]

1 Report for Kharif, op.cit., p 37.

2 Ibid.

3 Ibid.

4 Report for Rabi, op.cit., p 39.

5 Ibid.

6 A Planning Commission Study on the use of manures and fertilisers in different districts in India revealed that 90 per cent of the respondents in the sample of farmers who cultivated paddy, wheat, groundnut and sugarcane used nitrogen, Programme Evaluation Organisation, Study on the Use of Fertilisers and Manures in Agricultural Production, New Delhi, 1967, p 75.

7 Report for Rabi, op.cit., Appendix Table 5.

Nitrogenous fertilisers come in four different forms, Urea, Ammonium Sulphate (AS), Calcium Ammonium Nitrate (CAN) and Ammonium Sulphate Nitrate (ASN).[1] These sell at different prices.[2] For the cultivation of traditional varieties, Urea, ASN and CAN give equally good results and are each superior to AS.[3] In the case of IR-8 all three give better results than farmyard manure.[4] The analysis of the use of different forms of nitrogen on our sample farms reveals that small farmers preferred AS to other forms.[5] This is understandable as AS is the cheapest source of nitrogen. In general, judging by the average rate of application per acre, farmers preferred CAN, As and Urea being next in order of preference.[6]

The excessive reliance on nitrogenous fertilisers could be a reflection of many factors. We noted earlier that nitrogen is the universal requirement in the cultivation of rice.[7] Furthermore, nitrogen can be applied even in the absence of elaborate soil tests although the application of

1 The nitrogen content of these are 46 per cent, 20 per cent, 20.5 per cent and 26 per cent respectively, see Dogra,L. 'Economics of Fertiliser Use,' EPW, IV, 37, Sept. 1969, pp 1484-86.

2 In 1963 the price per quintal for Urea, AS, CAN were Rs 51-60, Rs 88.00 and Rs 56.00 respectively, Preliminary Report on the Study of HYVP (Kharif 1968-69, Phase I), op.cit., p 34.

3 Government of India, Ministry of Food & Agriculture, (Ministry of Food) Report of the Fertiliser Distribution Enquiry Committee, New Delhi, 1960, p38.

4 Prasad,B. & Shukla,S.C. 'Response of Rice (IR-8) to Different Sources of Nitrogen,' Madras Agriculturist, LVII, 10, 1970, pp 519-522, cited in Tropical Abstract, No. 7, July 1971, p 438.

5 Report for Kharif, op.cit., Appendix Table 5, Report for Rabi, op.cit., Appendix Table 5.

6 Ibid.

7 Refer above, p 113.

of nitrogen indiscriminately aggravates the tendency to lodge even in the case of the new varieties.[1] The absence of adequate soil testing fertilisers may be regarded as one of the factors responsible for the excessive dependence on nitrogenous fertilisers. The situation on our sample farms can be explained in this way. We find that although fertiliser recommendations were communicated to all size-classes of farms, soil tests were carried out on only one-third of the total number of sample farms in both the Kharif season and the Rabi season,[2] and these constitute farms above 5 acres in size. As we noticed earlier, these were precisely the farms where the average rates of application of phosphatic and potassic fertilisers were higher.[3] The actual and percentage distribution of farms which received fertiliser recommendations and had soil tests carried out is shown in Table III.7.

With regard to the use of nitrogen on cultivators' fields the experience of West Godavary is different from that of the other districts cultivating HYV. The PEO found that in all the eight districts in 1967

1 Ramamurthy,B. 'New Trends in Fertiliser Application,' IF, XV, 11, Feb. 1966, pp 13-14. Soil testing laboratories are limited in number and there is considerable under-utilisation of capacity, Anon, 'Hurdles in the Path of the Green Revolution,' Commerce, CXX, 3085, June 1970, p 1276. The recommended ratio of N to P in 1959-60 was 3:1. It is only recently, (1968-69) that it was changed to 2:1 for the country as a whole, Effective Demand for Fertilisers in India, op.cit., p 8. The growing importance of phosphatic and potassic fertilisers in recent years can be gathered from the production figures for all three types of fertilisers, refer Appendix Table XIII.

2 Report for Kharif, op.cit., p 35 ; Report for Rabi, op.cit., p 38.

3 Refer above, p 125.

Table III.7. Actual and Percentage Distribution of Farms receiving Fertiliser Recommendations and Soil Tests for Raising HYV, West Godavary, Kharif & Rabi, 1968-69

Size Group (acres)	Total Number of Selected Cultivators	Number of Cultivators who received Fertiliser Recommendations	3 as percentage of 2	Number of Farmers whose Farms received Soil Tests	4 as percentage of 2
1	2	3	4	5	6
Kharif					
Below 5.00	12	12	100	-	-
5.01 - 10.00	11	11	100	2	18.18
10.01 - 15.00	11	11	100	2	18.18
15.01 - 20.00	5	5	100	-	-
20.01 & Above	21	21	100	15	71.43
	60				
Rabi					
Below 5.00	14	14	100	2	14.29
5.01 - 10.00	8	8	100	4	50.00
10.01 - 15.00	4	4	100	2	50.00
15.01 - 20.00	2	2	100	1	50.00
20.01 & Above	2	2	100	1	50.00
	30				

Source: Report for Kharif, op.cit., Appendix Table, No. 23.
Report for Rabi, op.cit., Appendix Table, no. 19.

nitrogen was applied at only one-half the recommended dose.[1] The district is also singular in another respect. Among the 15 rice growing districts studied by the Institute of Agricultural Statistics in the course of assessing the profitability of paddy growing at different levels of nitrogen, it was one of two districts where a close relationship was observed between the calculated economic rate of application and the actual rate.[2]

Returning to the theme of the divergence between actual and recommended doses of fertiliser we find that this has been explained in various ways. The explanations offered include farmer's ignorance of yield-responses of the new varieties, non-availability of fertilisers in time for application and the unsuitability of some recommended doses, scepticism on the part of farmers about recommended doses and finally lack of irrigation.[3] From a study of farms in West Godavary, George and Choukidar found that farmers who used less than the recommended doses did so in the belief that they were too high. Those who exceeded the recommended doses felt that by doing so higher yields would be obtained.[4]

1 Government of India, Planning Commission, Programme Evaluation Organisation, Report on Evaluation of the Higher-Yielding Varieties Programme, Report for Kharif, 1967, p 61. For the nature and extent of divergence between actual and recommended doses during the subsequent years and for the extent of fields fertilised by different kinds of fertilisers, see Reports for Rabi 1967/68 (P41), Kharif 1968 (p45) and Rabi 1968/69 (pp 23-24); see also Fourth Five Year Plan, mid-term Appraisal, op.cit., p 65.

2 Effective Demand for Fertilisers in India, op.cit., p 10; the districts studied were IADP ones during the years 1967/68 to 1968/69. The doses of N ranged from 0 to 255 lbs per acre.

3 Report on High-Yielding Varieties Programme, Studies in Eight Districts, op.cit., pp 35 and 58.

4 George, P.S. and Choukidar, V.V. Production and Marketing Pattern of Paddy, op.cit., p 197.

III.2. Fertiliser Prices

Until 1967 the sale price and distribution of nitrogenous fertilisers was controlled by the Government. Fertilisers produced indigenously and those imported were pooled together and issued at uniform prices to individual states and plantations. Allocation of fertilisers to farmers at the state level was done by cooperatives.[1] Prices of Ammonium Chloride, Phosphates and Complex fertilisers were fixed by manufacturers who had the freedom to distribute their products through their own trade channels.[2] Following the recommendations of the Shivaraman Committee, the Government lifted controls on fertiliser prices with effect from October 1966.[3] The private sector was allowed to fix prices and organise its own distribution for a period of seven years from the commencement of production subject to the Government's option to take up 30 per cent of the total production at negotiated prices.[4] At present the Central Fertiliser Pool continues to handle all imported fertilisers.

In general, with very few exceptions, fertiliser prices are not subsidised. In some areas, especially hilly districts, the cost of transport is subsidised. In other areas subsidies of 25 per cent on the retail price of nitrogenous fertilisers and 50 per cent on phosphatic fertilisers are given.[5]

1 Lok Sabha Secretariat, Estimates Committee, 1967-68, 49th Report, Ministry of Chemicals and Petroleum, Fertilisers, New Delhi, pp 91-100.

2 Report of the Study Team on Agricultural Administration, Vol. 1, op.cit., p 160.

3 Government of India, Ministry of Food and Agriculture (Ministry of Agriculture) Report of the Committee on Fertilisers (Shivaraman Committee), New Delhi, 1965, p 37.

4 Ibid.

5 Report of the Study Team on Agricultural Administration, Vol. II, op.cit., p 833. The Shivaraman Committee argued against the need for subsidies in the mistaken belief that with technological advances in the fertiliser industry in India, fertiliser prices would fall, Report of the Committee on Fertilisers, op.cit., pp 25-26.

Table III.8. Pool Prices and Distribution Margins and Non-Pool Prices of Fertilisers at Various Dates in 1967 & 1969

Type of Fertiliser	Date	Pool Issue Price	Distribution Margin	Retail Price to Cultivator
Urea	Mar. 1969	863	80	943
Ammonium Sulphate (in bags of 100 kgs)	Aug. 1969	474	55	529
Ammonium Sulphate Nitrate	Apr. 1967	515	62	577
Calcium Ammonium Nitrate (20.5% N)	Apr. 1967	385	62	437
Ammonium Chloride	Mar. 1969	484	55	537
Muriate of Potash (61% K_2O	Mar. 1969	483	40	523
	Non-Pool Fertilisers			
Ammonium Chloride (25% N)	Jul. 1967			540
Ammonium Nitrate Phosphate	Mar. 1969			900
Urea Ammonium Phosphate	Mar. 1969			1232
NPK Mixture	Mar. 1969			870
Nitrophosphate	Aug. 1967			683

Source: Government of India, Economics and Statistics Division, Ministry of Petroleum and Chemicals, Mines and Metals, Indian Petroleum and Chemicals Statistics, New Delhi, 1969, pp 92-95.

Note: Pool prices refer to straight fertilisers and are those supplied to states rather than to plantations. Non-pool prices are exclusive of sales and local taxes. All prices after March 1969 include a 10 per cent excise duty, ad valorem.

Table III.8 gives the prices of pool and non-pool fertilisers along with the distribution margins for the former. Pool issue prices, (f.o.r.), to nearest rail-head chosen by purchasers (states or plantations) include the cost of fertiliser (either imported or locally manufactured), internal transport costs and departmental charges.[1] Distribution margins for pool fertilisers are fixed by the Central Government. The spread between the pool issue price and the retail price also includes sales tax and other local taxes and these vary from state to state.[2] Distribution margins in the case of non-pool fertilisers are hard to assess. Generally, speaking, they comprise everything between ex-factory and farmers' price exclusive of local taxes.[3] Transport charges form a very high proportion of distribution costs, constituting as much as 40 per cent of the latter.[4] In the case of pool fertilisers, one of the Government measures to encourage the use of fertilisers is the equalisation of transport charges. Thus, the pool issue prices shown in Table III.8 are those for fertilisers delivered at the nearest rail-head at uniform prices throughout the country. Since March 31, 1969, all fertilisers bear an excise duty of 10 per cent ad valorem.[5]

1 Administrative Reforms Commission, Vol. I, op.cit., pp 160-161.

2 Government of India, Ministry of Food and Agriculture, Department of Agriculture, Report of the Fertiliser Distribution Enquiry Committee, New Delhi, 1960, pp 43-46, Appendix VI, pp 110-111.

3 Expressed as a percentage of ex-factory or c.i.f. price the overall differences between the latter and prices paid by the farmer are of the following order - Single Superphosphate 33%, Muriate of Potash 24%, ASN 23% and CAN 33%. Development Centre of the Organisation for Economic Cooperations and Development, Supply and Demand Prospects for Fertilisers in Developing Countries, Paris 1968, p 170.

4 News and Notes: 'Fertiliser Industry in India,' Agricultural Situation in India, XXII, 9, Dec. 9 1967, p 1001.

5 It is held in some quarters that the slump in fertiliser consumption since Mar. 1969 is due to the fertiliser levy. Although there has not been any quantitative assessment of the impact of the levy, in a study of its impact, Kurien worked out the increase in the expenditure on fertilisers per hectare of cropped area for the States and All-India, Kurien,A.P. 'Impact of Fertiliser Levy,' EPW, IV, 23, July 7 1969, p 943; see also Anon, 'Levy not to blame.' EPW, IV, 43, Oct. 25 1969, p 1695.

In accounting for high prices of fertilisers in India we have to come to grips with a number of controversial issues in the Government's fertiliser policy.[1] Unlike the United States where the success of the wheat hybridisation programme was brought about by innovations in the fertiliser industry,[2] the success of HYVP in India is highly constrained by the overall shortage of fertiliser production.

1 The great controversies in fertiliser policy have been (and continue to be) public versus public production, cooperative versus private trade, the extent of foreign collaboration and the nature of feedstock for production. With a shortfall in the production of naptha at the end of the Fourth Plan now predicted, the controversy between indigenously produced naptha and imported ammonia may be deemed to be settled now. It was this controversy that led to the search for alternative forms of feedstock such as coal, petroleum and atomic energy. Future expansion of fertiliser production is hoped to be based on coal. Of necessity, this implies a committment on fuel policy, but even now there is no integrated approach to the provision of fuels in the economy and fertiliser production. In any case with the present international oil crisis the problems other than the question of the nature of feedstock are academic, the immediate problem being one of finding the wherewithal for fertiliser production. The conflicting issues in fertiliser policy are brought out clearly in the following references: Editorial, EPW, IV, 21, May 1969, p 861; Fourth Five Year Plan, op.cit., p 320; Anon, 'Coal-based Fertilisers,' EPW, IV, 17, April 1969, p 710; Anon, 'Fertilisers at any Cost,' EPW, V, 8, Feb. 1970, p 352; Anon, 'Not by Naptha Alone,' EPW, V, 23, June 1970, p 894. For the impact of the recent oil crisis on fertiliser production see, Brogan,P. 'The Third World's Devastating Oil Burden,' The Times, Jan. 30, 1974; Rafferty,K. 'India: Dearer Oil Hardens the Threat of Perpetual Poverty,' The Financial Times, Jan. 15, 1974.

2 Griliches,Z. 'The Demand for Fertilisers - An Economic Interpretation of a Technical Change,' Journal of Farm Economics, XL, 3, Aug. 1958, pp 591-606. The situation was similar in Japan between 1955 and 1964. Important industrial innovations reduced the cost and increased the effectiveness of chemical fertilisers, Johnston,B.F. 'Agriculture and Economic Development,' Food Research Institute Studies, VI, 3, 1966, pp 251-312.

The Shivaraman Committee estimated that against a minimum requirement of 1.7, 2.0 and 2.4 million tons during 1968-69, 1969-70 and 1970-71 respectively, domestic productiom will only be 1.1, 1.4 and 1.7 million tons respectively thus leaving an average supply gap of 0.6 - 0.7 million tonnes.[1] More recently, the Study Group for Fertilisers appointed by the National Commission for Labour estimated annual shortfalls of 0.99, 1.05 and 1.02 million tonnes of nitrogen for 1967-68, 1968-69 and 1969-70 respectively.[2] Initially, the deadline for achieving self-sufficiency was 1975-76 but on the basis of calculations made by the Ministry of Petroleum and Chemicals it was extended by a year. Accordingly, the Planning Commission in its mid-term appraisal of the Fourth Plan, scaled down the original consumption targets of consumption of 3.2 million tonnes of N and 1.4 million tonnes of P_2O_5 and 0.92 million tonnes of K_2O to 2.6 million tonnes, 0.81 million tonnes and 0.52 million tonnes respectively.[3] The targets for production were revised downwards correspondingly. Even the revised targets appear unlikely to be realised because total capacity at the end of 1971-72 was only 1.35 million tonnes.[4]

1 Report of the Committee on Fertilisers, op.cit., For a detailed breakdown of nitrogenous fertilisers in India since 1964, see Appendix Table XIII, Fertiliser production showed a rising trend until 1968, the growth rates being 23.1, 31.1, 22.1 and 19.8 in 1967, 1968, 1969 and 1970 respectively; figures from 1967 to 1969 are taken from Government of India, Economic Survey, 1970-71, pp 13-14, that for 1970 from Economic Survey, 1971-72, p 4. The latest data available also suggests that the gap between requirement is so large as to warrant imports amounting to Rs 300 crs at the end of the Fifth Plan, Anon, 'Fertiliser Gap,' ASI, LXXVII, 10, Jan. 1973, p 670.

2 National Commission on Labour, Report of the Committee on Fertilisers, 1969, p 10.

3 Government of India, Planning Commission, Fourth Plan mid-term Appraisal, Vol. I, Dec. 1971, pp 9-10.

4 Ibid., p 10; see also, Anon, 'Self-sufficiency still far away,' Commerce, Vol. 125, no. 3199, Aug. 26 1972, p 496, and Anon, 'Rationalising Fertiliser Use,' Eastern Economist, LXI, 23, Dec. 7 1973, p 1055.

The shortage of supply of fertilisers in India over the Planning period was due to the limited growth in output of fertilisers. One of the main obstacles in the expansion of fertiliser production today is the lack of foreign exchange for the purchase of plant and equipment.[1] Shortage of raw materials for production of fertilisers also necessitates their import thereby making further demands on foreign exchange.[2] While these imported components are responsible for the high cost of fertiliser production, over-capitalisation is also a contributory factor.[3] Along with high production costs, delays in commissioning new projects due to "procedural difficulties" and managerial problems besetting existing projects in the public sector are further causes for the shortage of fertiliser supply.[4]

1 Approximately half the capital cost necessary for the construction of a large project is in terms of foreign exchange, United Nations, Factors Inhibiting the Indigenous Growth of the Fertiliser Industry in Developing Countries, Report of the Ad Hoc Group of Experts from Fertiliser Deficit Countries, New York, 1969, p 6. Owing to the limited availability of foreign exchange, India is dependent on suppliers' credit in purchasing machinery and equipment. This automatically gets reflected in higher prices than would be applicable under a competitive system of open global tendering, John,K.K. 'Towards Cost Reduction,' in Dagli,V. (Ed) Foundations of Indian Agriculture, Commerce Economic Studies I, Vora and Co., Bombay, 1968, pp 191-196.

2 Imports of naptha, ammonia and rock phosphate continue to be made either because they are in short supply or they are not available domestically at all, Government of India, Economic Survey, 1971-72, p 61. Indigenous production supplies only 20 per cent of the raw materials for the production of Phosphatic fertilisers, Business Report, 'Fertilisers - Changing Pattern of Consumption,' Commerce, Vol. 124, No. 3170, Feb. 5, 1972, p 244.

3 Mukherjee,S.K. 'Cost Reduction in Engineering of Field Costs,' in Sirur,S.S. (Ed) Proceedings of the Seminar on Costs and Financing of Fertiliser Projects in India, New Delhi, 1967, pp 71-77.

4 "... the solution of certain persisting problems in the administrative system" is regarded as being the precondition for stepping up fertiliser output - whether this is brought about by increasing the utilisation of existing capacity or by adding to the existing capacity by completing projects on schedule, Ministry of Finance, Economic Survey, 1971-72, p 61. For a general review of the critical problems facing fertilisers projects in the public sector in India, see Repetto,R.C. Time in India's Development Programmes, Harvard University Press, Cambridge, Mass., 1971, Chapter III, 'The Pace of Infant Industry Economics : A Study of the Fertiliser Corporation of India,' pp 45-71.

To these factors must be added the consequences of the under-utilisation of capacity. Plants in the public sector worked at 57.3 per cent of their capacity compared with a capacity utilisation of 68.3 per cent in the private sector. The average for the industry as a whole at the beginning of the Fourth Plan was 62.7 per cent.[1] Under-utilisation of capacity increased to 67.5 per cent between 1968-69 and 1971-72.[2] Shortage of steel, delays in the supply of equipment by local manufacturers and foreign exchange shortage are some of the factors contributing to this phenomenon.[3]

Whereas the shortage of fertiliser is a worrying problem there is evidence to show that in recent times the problem is one of declining demand. There has been a marked slowing down of demand for fertilisers.[4] Mellor and Desai were the first to draw attention to this phenomenon. According to their estimates, cultivators' demand for nitrogenous fertilisers will fall short of the Planning Commission's target of 3 million tonnes by 1 million tonne.[5] The Planning Commission itself forsees an overall shortfall of 1.5 million tonnes. According to the Planning Commission's calculations, in order to achieve the agricultural production target in the Fourth Plan, the use of NPK must increase by an annual compound rate of 26.6 per cent. The annual compound rate actually achieved during the first two years of the Plan was only 11.7 per cent.[6]

1 Anon, 'Self-sufficiency still far away,' op.cit., p 496.

2 Anon, 'Fertiliser Gap,' op.cit., p 670.

3 National Council of Applied Economic Research, Under-utilisation of Industrial Capacity, New Delhi, 1966, pp 44-47.

4 Evidence of the slowing down of demand can be gathered from a large number of sources both official and non-official, Fourth Five Year Plan, op.cit., p 131; Anon, 'Fertilisers - a Blue print for Filling the Gap,' Commerce, Vol. 120, No. 3062, Jan. 17, 1970, p 71; Anon, 'Fertiliser Blues,' EPW, V, 18, May 2 1970, p 724; Anon, 'Fertilisers - A Necessary Change of Focus,' EPW, VII, 10, March 4, 1972, pp 527-528.

5 Mellor and Desai, 'Changing Basis of Demand for Fertilisers,' op.cit., p A176.

6 Fourth Five Year Plan, mid-Term Appraisal, op.cit., Vol. II, p 66.

It is not difficult to find reasons for the decline of demand for fertilisers. At the present stage in the propagation of the new varieties, further increases in demand will require substantial increases in the area irrigated and the adoption of multiple-cropping. Also, as varietial characteristics set the limit to the absorption of fertilisers by different varieties, increases in the rate of consumption of fertilisers will require the evolution of even newer varieties.[1] Important as the above factors are, the present organisation of institutional credit dominated by the cooperatives which have the dual role of being both the distribution machinery and the medium for the propogation of the new technology is largely responsible for the slow growth in demand for fertilisers.[2] We turn now to the nature of the distribution machinery and its efficiency.

1 Swaminathan, 'Scientific Implications of High-Yielding Varieties, op.cit., pp 71-75.

2 RAIRCRC,op.cit., p 880.

III.3. Supply and Distribution of Fertilisers

Distribution of fertilisers encompasses a wide area of activities. They include the formulation of targets of consumption at the state and district levels,[1] transportation, provision of credit for the purchase of fertilisers by farmers and extension services for the education of farmers in their proper use. The distribution problem assumes great importance in the context of the new strategy because the varietal characteristics of the new seeds require a scientific approach to the application of fertilisers.

Existing arrangements for the supply of fertilisers to farmers are a legacy of the distribution pattern under the Central Fertiliser Pool.[2] In 1967-68 supplies from the Pool constituted 92 per cent of nitrogenous fertilisers distributed in the country.[3] Credit facilities made available by the Central Government enabled state governments to distribute fertilisers through cooperatives on the basis of consignment credit as part of state trading activities. The other channels of fertiliser distribution are

1 The proposed targets for Andhra Pradesh during the Fourth Plan were less than the requirements based on fertiliser recommendations for various crops. The discrepancy is shown in the following figures:

Cropped Area (acres)	Potential Requirement based on Fertiliser Recommendations (tonnes)			Proposed Target (tonnes)		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
37.29	279559	171299	118716	232478	129146	79457

Source: Shivaraman Committee Report, op.cit., p 165.

2 Fertiliser distribution is governed by the Fertiliser Control Order of 1957, see Fertiliser Control Order of 1957 under section 3 of Essential Commodities Act of 1955. It has been amended twice. The purpose of the Order is to ensure equitable distribution, fix maximum retail prices for nitrogenous fertilisers (20 per cent of N at any given time) by retailers, The Gazette of India Extraordinary, No. 165, Saturday, July 7, 1973.

3 Quraishi,M.A. 'Fertiliser Distribution through Institutional Agencies,' Kurukshetra, XXI, Jan. 8 1973, pp 4-5.

government departments, indigenous manufacturers and agro-economic corporations. Arrangements for distribution vary from state to state.

Until the lifting of controls of fertiliser prices in 1967, cooperatives had the monopoly in the distribution of fertilisers in Andhra Pradesh, accounting for 66 per cent of the total amount distributed.[1] In West Godavary, too, cooperatives accounted for 66 per cent of the total amount distributed, the Agricultural Department and other official sources accounting for 16 per cent and 18 per cent respectively.[2] The organisation of distribution is similar to that in East Godavary which was one of the districts chosen by the Programme Evaluation Organisation in its study of fertiliser programmes. The District Fertiliser Committee, headed by the Collector makes the final approval of the proposals for distribution put forward by the District Agricultural Officer. Distribution of fertilisers to development blocks is made on the basis of prescribed criteria according to different crop areas. The distribution chart is then communicated to the different blocks and to the District Market Society which received supplies direct from the factories. The District Marketing Society then supplied fertilisers to different blocks through its agents, the cooperatives.[4]

1 Raghavelu,C.V. 'Fertiliser Distribution through Cooperatives,' EPW, IV, 40, Oct. 1969, pp 1590-91; National Council of Applied Research, Factors Affecting the Demand for Fertilisers - Problems and Policies, New Delhi, 1964, p 58; see also, Parasker,R.K. 'Farmers, Fertilisers and Supply Lines,' ASI, XX, 11, Feb. 1966, pp 873-879.

2 Factors affecting Demand for Fertilisers - Problems and Policies, op.cit., p 58.

3 Government of India, Planning Commission, Programme Evaluation Organisation, Problems of Coordination in Agricultural Programmes, New Delhi, 1965, p 15.

4 Ibid., pp 17-19; for an illustration of a typical distribution chart, see Chart I, Appendix.

Since the introduction of HYVP, allocation of fertilisers from central stocks to Andhra Pradesh, in common with other states has been on the basis of targetted area under different crops and the corresponding fertiliser recommendations. With the entry of private trade in the supply of nitrogenous fertilisers and the liberalisation of import restrictions,[1] there has been some easing of the supply position for the state as a whole. All the same, the PEO found that there were several rigidities in the distribution of fertilisers because of the preferential treatment given to HYV areas and virtually no allocation to non-HYV areas.[2] It also found that estimates of fertiliser requirements in individual state indents were highly inflated. It noted, however, that for the first time attention was paid to individual crop requirements in the allocation of fertilisers.[3]

1 Imports of fertilisers and fertiliser materials increased by 47 per cent between 1966-67 amd 1968-69 as a consequence of the liberalised policy of imports inaugurated in 1967 in pursuance of the new Agricultural Strategy, Government of India, Economic Survey, 1968-69, p 31; see also Government of India, Directorate of Economics and Statistics, Ministry of Food and Agriculture, Community Development and Cooperation, Economic Survey of Indian Agriculture, New Delhi, 1967-68, pp 119-120. Imports of fertilisers (crude and manufactured) as a percentage of total imports of agricultural commodities increased during 1966-67 and 1968-69.

Fertiliser	1966-67	1967-68	1968-69
Manufactured	9.2	16.0	19.6
Crude	1.4	1.1	1.8

Economic Survey of Indian Agriculture, op.cit., 1967-68 (p 121), 1968-69 (p 95).

2 Report on the Evaluation of High-Yielding Varieties Programme, Kharif 1968, op.cit., pp 29-31.

3 Ibid.

Although the aim of lifting controls on fertiliser prices was to remove the monopoly of cooperatives, to date, they still command a large share of the total amount distributed. In 1972, cooperatives accounted for 60 per cent of the total amount of fertilisers distributed in Andhra Pradesh.[1] This reduction in the share of total distribution from 66 per cent in 1967 to 60 per cent in 1972, is due to two factors, the reduction in the allocations from the Central Fertiliser Pool and the consequent decline in the volume of consignment credit provided by the central government and the increasing importance of commercial banks in the supply of credit.[2] The Fertiliser Credit Committee which examined the implications of the lifting of controls on fertiliser prices noted two principal problems associated with the distribution of fertilisers by cooperatives.[3] They are the need to ensure timely supplies of fertilisers on farms, because the demand for fertilisers is seasonal, and the need to promote new types of fertilisers. The Committee observed that in some districts, supplies were received too late for the Kharif crop. The delay was due to the late arrival of stocks at ports, inadequate transport facilities, and the absence of buffer stocks. The inability of the cooperatives to cope with these problems was as much due to the activities of the state departments as due to their poor financial and organisational resources. The Committee was convinced, however, that without the lifting of controls the situation would have been a lot more grim.

1 Notes: ASI, XXVII, Sept. 6 1972, p 407. For the country as a whole, the share of cooperatives in the sale of fertilisers went down from 72 per cent in 1965-66 to 57 per cent in 1966-67 and is expected to settle at 55-60 per cent of total sales, RAIRCRC, op.cit., p 880.

2 RAIRCRC, op.cit., p 880.

3 Report of the Fertiliser Credit Committee of the Fertiliser Association of India, cited by Madalgi, G.S. Population and Food Supply, Lalvani Publishing House, Bombay, 1970, p 188.

The observations of the Fertiliser Credit Committee are relevant in the context of the New Strategy because they highlight the problem of distribution of fertilisers. Under the HYVP, cooperatives are not only the machinery for distributing fertilisers but constitute the medium for the propogation of the new technology.[1] Their task is a difficult one because with the abolition of the Central Fertiliser Pool and the enlargement of the sphere of private trade, they face competition in acquiring fertilisers. With regard to the distribution of fertilisers their most important function is the provision of credit. Here again, their monopoly has been eroded by the entry of commercial banks in the financing of agriculture.[2] The importance of credit arises from the fact that more than 50 per cent of expenditure on fertilisers is financed by credit provided by institutional agencies.[3] The Shivaraman Committee had envisaged that by 1970-71, credit sales of fertilisers would account for 70 per cent of consumption.[4]

1 Fourth Five Year Plan, op.cit., pp 113-115.

2 RAIRCRC, op.cit., p 880. Before the emergence of commercial banks on the rural scene, cooperatives and government departments were the two most important sources of agricultural credit. The Reserve Bank of India extends credit to cooperatives to the extent of 90 per cent of the value of fertilisers in stock and in transit. Apart from these institutions some agro-processing industries also grant fertiliser credit to farmers. The Food Corporation of India also supplies fertilisers in exchange for foodgrains, Report of the Study Team on Agricultural Administration, op.cit., Vol. I, p 167.

3 RAIRCRC, op.cit., p 78.

4 Shivaraman Committee Report, op.cit., p 37. Figures for Andhra Pradesh are hard to come by, but we can assume that predictions of likely increase for the whole of India are applicable. The AIRCRC estimated that the actual value of fertilisers handled by cooperatives will increase by 18 per cent between 1966-67 and 1973-74, RAIRCRC op.cit., p 78.

The most important facility offered by cooperatives for the purchase of fertilisers is short-term loans and that offered by the Agricultural Department in Andhra Pradesh takes the form of either Taccavi loans or loans granted under the Intensive Manuring Scheme.[1] Funds for giving Taccavi loans to farmers are allocated by the Revenue Department.[2] For the purchase of fertilisers a maximum amount of Rs 120 per farmer is granted, half of which is in kind. Loans given under the Intensive Manuring Scheme are given entirely in kind.[3] These arrangements existed before the start of HYVP. The sources of finance for meeting per acre expenditure on fertilisers in West Godavary during the Kharif and Rabi seasons in 1968-69 are given in Table III.9. Cultivators' own funds[4] was the major source of finance for the purchase of fertilisers in both seasons. Between seasons, cooperatives accounted for a higher proportion of the financing of fertilisers relative to private moneylenders in the Kharif season. Whereas, 20 per cent of the total cost of fertilisers was financed by cooperative credit in the Kharif season, they accounted for only 10 per cent in the Rabi season. In the Rabi season, however, private moneylenders contributed a larger share (38 per cent) of total credit taken by farmers than cooperatives which contributed only 10 per cent.

1 Problems of Coordination in Agricultural Programmes, op.cit., p 23.

2 Loc.cit.

3 Loc.cit.

4 The nature of these funds is discussed in the Chapter on Credit; see below p 227.

Table III.9. Per Acre Expenditure on Fertiliser and Source of Finance, West Godavary, Kharif, Rabi, 1968-69 (Rs/a)

Total Expenditure	Source of Finance		
	Own Funds	Cooperatives	Private Moneylender
Kharif			
139 (100.00)	102 (73.00)	27 (20.00)	10 (7.00)
Rabi			
239 (100.00)	125 (52.00)	24 (10.00)	100 (38.00)

Source: Report for Kharif, p 53; Report for Rabi, p 54.
Note: Figures in brackets refer to percentages.

The relative importance of cooperatives and moneylenders is brought into greater relief when considered in relation to the size distribution of farms; this is shown in Table III.10. In the Kharif season, own funds were the chief source of finance in the case of all farms except farms between 15-20 acres, where cooperative credit is more important. Private moneylenders did not figure as important source of finance for any farm size. They are, however, an important source of finance in the case of farms up to 10 acres in the Rabi season. For farms above 10 acres own funds were the chief source of finance. In general, in the Rabi season, cooperatives were a secondary source of finance, farms between 10 and 15 acres accounting for a higher proportion of total amount borrowed than any other farm size.

Table III.10. Per Acre Expenditure on Fertilisers for IR-8 and Sources of Finance, West Godavary, Kharif and Rabi, 1968-69

Farm Size (acres)	Value of Fertilisers	Source of Finance		
		Own	Cooperative Societies	Private Moneylender
1	2	3	4	5
Kharif				
Below 5.00	139.44 (100.00)	75.82 (54.37)	58.62 (42.04)	5.00 (3.09)
5.01 - 10.00	123.98 (100.00)	74.44 (60.04)	10.63 (8.57)	38.91 (31.38)
10.01 - 15.00	106.96 (100.00)	87.23 (81.55)	19.73 (18.45)	- (-)
15.01 - 20.00	99.04 (100.00)	37.02 (37.38)	62.02 (62.62)	- (-)
20.01 & Above	146.15 (100.00)	111.93 (76.59)	24.78 (16.96)	9.44 (6.45)
All Farms	138.87 (100.00)	101.99 (73.44)	27.15 (19.55)	9.73 (7.01)
Rabi				
Below 5.00	208.60 (100.00)	51.28 (24.58)	4.70 (2.25)	152.62 (73.17)
5.01 - 10.00	216.19 (100.00)	17.23 (7.97)	- (-)	198.96 (92.03)
10.01 - 15.00	224.54 (100.00)	137.18 (61.09)	87.36 (38.91)	- (-)
15.01 - 20.00	248.40 (100.00)	197.60 (79.55)	50.80 (20.45)	- (-)
20.01 & Above	329.23 (100.00)	329.23 (100.00)	- (-)	- (-)
All Farms	239.06 (100.00)	124.80 (52.20)	23.71 (9.92)	90.55 (37.88)

Source: Report for Kharif, op.cit., Appendix Table 34. Report for Rabi, op.cit., Appendix Table 26.

Note: Figures in brackets refer to percentages.

No definite pattern emerges from the analysis of borrowing for the purchase of fertilisers either by source of finance or size-class of farms. The dependence of farms on moneylenders by farms below 10.00 acres in size in the Rabi season could be a reflection of the fact that the profitability of HYV in this season being greater than during the Kharif season,[1] such farms found it worthwhile to use fertilisers even at the risk of falling into the clutches of moneylenders. Another presumption could be that this size-class of farmers are share-croppers cultivating HYV and using fertilisers bought by means of funds supplied by the landlord who might be an agricultural moneylender.

In addition to the size of farms, tenurial conditions have a significant effect on fertiliser use. The Shivaraman Committee noted that owner-cultivators applied higher doses of fertilisers than tenants.[2] Tenancy arrangements with regard to the use of fertilisers for IR-8 in West Godavary follow a pattern similar to that governing the cultivation of traditional varieties. They differ between seasons. Parthasarathy observed the following arrangements from a study of three villages, Koppale, Pedakapavaram and Palakoderu in West Godavary.[3] Terms of tenancy for the cultivation of traditional paddy in the Kharif season are of two kinds: fixed rent and crop-sharing. The latter system is more prevalent and here the landlord receives two-thirds of the gross produce and the tenant one-third. All expenses except

1 Refer above, p 118.

2 Report of the Committee on Fertilisers, (Shivaraman Committee), op.cit., p 164. Whereas owner-cultivators applied 6.2 kgs per acre of N, tenants used only 4 kgs per acre. The data refer to the district of Srikakulam in Andhra Pradesh.

3 Parthasarathy, G. Agricultural Development and Small Farmers - A Study of Andhra Pradesh, op.cit., pp 68-69.

those on fertilisers and pesticides are borne by the tenant. Cost of fertilisers are shared between tenant and landlord in the same proportion as gross produce. In the two villages of Koppale and Pedakapavaram, Parthasarathy noted that both tenants and landlords found that under the system of crop-sharing the cultivation of IR-8 was not profitable. In Palakoderu, however, cultivation of IR-8 was profitable but the transition from the cultivation to IR-8 was slow. Tenants had to obtain prior permission from the landlord to shift to the cultivation of IR-8. Where landlords were non-residents in the village, they could not ensure that tenants applied fertilisers on leased-in land.

In the Rabi season crop-sharing is the more usual form of tenancy for the cultivation of traditional paddy. Costs of fertilisers and pesticides are shared in the same ratio as gross produce, namely 2:1.[1] The use of fertilisers is significant in the Rabi season because farm yard manure is not available during this period.[2] This could account for the dependence on moneylenders by farms below 10.00 acres in this season, Table III.10.

1 The cost of fertilisers being the most important item in the total cost of purchased inputs, the impact of different tenurial arrangement on fertiliser use is a significant aspect of the cultivation of HYV. We argued elsewhere (refer pp 40-50, above) how crop-sharing is inimical to productivity increases. Ladejinsky pointed out how exorbitant rents charged by landlords under such an arrangement in West Godavary prevented the use of fertilisers by tenants, A Study of Tenurial Conditions in the Package Districts, op.cit., p 23. Vyas takes exception to the general contention that crop-sharing causes disincentives in fertiliser use. According to him the effect of crop-sharing depends upon whether the lessor is a large farmer or a small farmer and whether the context is that of traditional agriculture or one experiencing technical change. Drawing his data from Gujarat he shows how open and regulated tenancy can in fact promote agricultural productivity, Vyas,V.S. 'Tenancy in a Dynamic Setting,' EPW, V, 26, June 1970, pp A73-A80.

The picture that emerges from tables III.9 and III.10 is that in West Godavary cooperatives have not been an effective source of finance for the purchase of fertilisers. Taking the state as a whole in June 1971 the Central Cooperative Banks' distribution of credit for the purchase of fertilisers constituted only 2 per cent of the total credit made available to farmers.[1] Cooperatives being the most important source of supply of fertilisers, their inadequacy in meeting fertiliser needs can be seen from the gap between the annual compound rate of growth of consumption of N of 8 per cent and the actual rate of less than 1 per cent during the Fourth Five Year Plan period.[2]

As credit requirements for the purchase of fertilisers are part of total credit needs of farmers for the cultivation of HYV, the analysis of the reasons for the failure of cooperatives in financing farm inputs in general is postponed until Chapter V. Here we shall be concerned only with the inadequacies in the distribution of fertilisers by cooperatives. The Agricultural Reforms Commission observed that the lack of coordination of the activities of cooperatives and state agricultural departments were largely to blame.[3] The Fertiliser Credit Committee found that appreciable quantities of fertilisers were dumped by state agricultural departments on

1 Reserve Bank of India, <u>Statistical Statements Relating to the Cooperative Movement in India,</u> Part I (Credit Societies), 1970-71, Bombay, p 25.

2 Planning Commission, <u>Fourth Five Year Plan</u>, <u>Vol. II</u>, <u>op.cit.</u>, Annexure VII and VIII, p 74.

3 Agricultural Reforms Commission, <u>Report of the Study Team on Agricultural Administration</u>, Vol. I and II, New Delhi, 1967, Vol. I, pp 164-165.

cooperatives.[1] Untimely supplies of fertilisers created problems of storage, Cooperatives also suffered from delays in adjusting money owed to them by the government in respect of the value of fertilisers supplied by them to cultivators against taccavi loans, Crowning all this is the fact that cooperatives are crippled by the lack of funds.[2] While these problems relate to credit supplied by cooperatives to farmers for the purchase of fertilisers,

1 Agricultural Reforms Commission, Report of the Study Team on Agricultural Administration, Vol. I, op.cit., pp 164-165. The situation with regard to the dumping of fertilisers on cooperatives and dealers persists even now. Unofficial reports claim that stocks of fertilisers got accumulated with cooperative federations. It is claimed that in Andhra Pradesh the Marketing Federation had a glut of fertilisers of about 7,000 tonnes, Agriculture Correspondent, The Hindu, Dec. 17 1974.

2 One of the reasons for the ineffectiveness of cooperatives in marketing fertilisers is their small distribution margins, Quraishi,M.A. 'Fertiliser Distribution through Institutional Agencies,' Kurukshetra, XXI, Jan. 8 1973, pp 4-5. The Shivaraman Committee recommended that existing distribution margins should be raised by 50 per cent. It ascribed malpractices found in the distribution of fertilisers to small distribution margins. Report of the Committee on Fertilisers (Shivaraman Committee), op.cit., pp 60-62. As there are economies of scale in fertiliser distribution, for cooperatives to be economically viable, they must have a minimum annual turnover. The situation is similar to that faced by firms in the private sector. An important fertiliser distribution firm in India estimated that in order to have a viable retail outlet the annual turnover must be at least 100 tons. In 1968 a similar firm moved 250,000 tons through 6000 outlets giving an annual turnover of 50 tons, Supply and Demand Prospects for Fertilisers in Developing Countries, op.cit., p 73. The situation in India contrasts sharply with that in Japan where 95 per cent of fertiliser consumption is channelled through cooperatives, ibid., p 76.

there is another problem equally worrying. The problem is how to ensure that credit supplied to farmers is actually used to buy fertilisers. The compulsory lifting of fertilisers in kind under the Crop Loan System was a measure designed to solve this problem. But even this system has not had a noticeable effect in making farmers apply the fertilisers they receive. One of the reasons for the failure of the Crop Loan System is that the kind of fertilisers made available is usually not the one wanted by farmers or even preferred by them.[1] Another discouraging feature is that farmers re-sold fertilisers obtained from cooperatives. While this practice was observed by the Programme Evaluation Organisation even before the advent of HYVP, such practices continue to exist.[2]

The solution to the problem of ensuring that farmers actually apply fertilisers supplied by cooperatives will depend to a large extent on the effectiveness of extension agencies and the promotional activities pursued by the various official bodies. As the analysis of the organisation and effectiveness of extension agencies lies outside the scope of the present thesis we shall merely echo the observation made by the Programme Evaluation

1 Programme Evaluation Organisation, Report on Evaluation of Higher-Yielding Varieties Programme, Report for Kharif, 1967, op.cit., p 61; Problems of Coordination in Agricultural Programmes, op.cit., pp 25-27. The AIRCRC recommendation to relax the policy of cooperatives to disburse fertilisers in kind was dictated by the awareness that there were not enough distribution centres and supplies of fertilisers, RAIRCRC op.cit., pp 480-482. See also Chapter V, Section V below.

2 Anon, 'Rationalising Fertiliser Use,' Eastern Economist, LXI, Dec. 23 1973, p 1055; Parthasarathy,G. Green Revolution and the Weaker Section, op.cit., p 36.

Organisation that if there is no effective supervision of the implementation of production plans drawn up by Village Level Workers these plans will be of no avail in raising agricultural production.[1] Recognising the seriousness of the problem of distribution, the Fertiliser Association of India chose for its annual Seminar in 1970 the theme, "Coordinated Marketing and the Use of Fertilisers and other Inputs."[2] Among the various suggestions put forward for improving the machinery for distribution, the one relating to fertiliser credit cards is a useful one. According to this system, credit sanctioned to a farmer will enable him to purchase the type of fertiliser he required from any approved dealer. The advantages claimed for the system are that it will ensure timely availability of fertilisers, will prevent the misuse

1 Programme Evaluation Organisation, Problems of Coordination in Agricultural Programmes, op.cit., pp 61-62. The advent of planning saw the setting up of the National Extension Service and the Community Development Blocks. Since the introduction of the New Agricultural Strategy there was an expansion in the scope of their activities. A programme of training farmers in improved agronomic practices was started on a pilot basis in 1966-67. It was supported by a programme of National Demonstrations. For a summary of nature of extension services under HYVP see, Government of India, Directorate of Economics and Statistics, Ministry of Agriculture, Progress of Agriculture in India, New Delhi, 1972, Chapter VIII, pp 53-55. With a view to narrowing the gap between recommended levels of fertiliser use and actual levels the Government are reassessing the recommended doses of fertilisers for HYV, Government of India, Economic Survey, 1970-71, p 21; Anon, 'Fertiliser Promotion Programmes,' ASI, XXVII, 8, Nov. 1972, p 538.

2 Shivamaggi,H.G. 'Problems of Fertiliser Distribution and Use,' EPW, VI, 52, Dec. 25 1971, pp A154-A156.

of credit in the form of cash loans and it will educate the farmer in simple accounting techniques.

Recent data for the states of Andhra Pradesh and Tamil Nadu suggest that the working of the system of fertiliser credit has been far from satisfactory. Often, farmers found that the distribution centres to which they were directed by various extension agencies had no stocks of fertilisers.[1] There were bottlenecks even in the allocation of fertiliser cards. The Gram Sevak was expected to cover an area too large to enable him to allocate the cards efficiently.[2] An unofficial survey on fertiliser off-take in the Southern region showed that in 1974 fertiliser use in the cultivation of rice fell by as much as 20-25 per cent in the case of nitrogen and 35-50 per cent in the case of phosphates compared to previous years.[3]

The fall in fertiliser consumption cannot be ascribed to the shortcomings of the distribution machinery alone. Ultimately it is due to the overall shortage of fertilisers and the consequent high prices. The world oil crisis has created a formidable constraint for India in increasing fertiliser production. With the increase in the world prices for crude oil in 1974, India experienced a three-fold increase in the import bill for crude oil.[4] As a result she was forced to raise indigenous fertiliser prices by 90 per cent.[5]

1 Agricultural Correspondent, 'Fertiliser Distribution,' The Hindu, Dec. 27 1974.

2 Ibid.

3 Ibid.

4 Calcutta Correspondent, 'Adequate Supply of Fertilisers Vital,' Financial Times, July 11, 1974.

5 Ibid.

A consequence of limited overall supply of fertilisers and unsatisfied demand at the micro-level is the roaring black market in fertilisers all over the countryside.[1] Although official sources refer to the doubling of fertiliser prices in 1974, open market prices went up by nearly 400 per cent.[2] As a result of high fertiliser prices the profitability of cultivating HYV rice has been considerably reduced. While we have no firm data on the non-profitability of fertiliser use on our sample farms we do have some indirect evidence for the state as a whole. The unofficial study referred to earlier noted that there was a decrease in the area seeded to HYV rice in Andhra Pradesh and a significant amount was diverted from rice to the cultivation of cotton.[3] Furthermore, in so far as fertilisers were used for rice cultivation,only low grade fertilisers were applied. A factor contributing to the lack of profitability of fertiliser use is the system of levies in Andhra Pradesh. In West Godavary and Krishna there is a 75 per cent levy on millers and traders and a graded levy on cultivators.[4]

1 Calcutta Correspondent, 'Adequate Supply of Fertilisers Vital,' Financial Times, July 11, 1974.

2 This information was obtained from conversations with some farmers in Mysore and Kerala.

3 Agriculture Correspondent, 'Fertiliser Distribution,' The Hindu, Dec. 27 1974.

4 Government of India, Ministry of Agriculture, Directorate of Economics and Statistics, Bulletin on Food Statistics, Twenty-third Issue ,1973, p 194. Foodgrain levies are part of the regulations relating to the Government's policy of procurement of foodgrains. These require producers or middlemen (millers/traders) to sell a proportion of their total production or marketings to the government at fixed prices. Frequently the levy is graded with the percentage levied increasing with the amount marketed or produced.

While the compulsory levy limits the scope of farmers to sell in the open market, the low official procurement price acts as a disincentive in the use of fertilisers for rice cultivation. When the open market price of Akkullu, the popular standard variety in Andhra Pradesh was Rs 85 per bag of 75 kgs during Rabi 1974-75, the procurement price was only Rs 58 per bag of 75 kgs.[1] As a result of the dual prices for paddy, the state government is finding it increasingly difficult to fulfill its procurement target because farmers are holding on to stocks in the hope of selling paddy in the open market.[2] In the light of high fertiliser prices this action by farmers is understandable for they need high paddy prices to recoup the cost of using fertilisers, but the implications for the system of public distribution are not favourable.[3]

Our analysis of the supply and distribution of fertilisers has served to highlight an important bottleneck in the propogation of HYV rice,

1 Vijayawada Correspondent, 'Setback to rice procurement in Coastal Andhra,' The Hindu, Jan. 3 1975.

2 Ibid.

3 Although procurement prices are in effect support prices in India, these prices have failed to achieve targets set for procurement of foodgrains. During 1972-73m the Food Corporation of India succeeded in obtaining only half its target of 4 million tons of rice, Anon, 'Shortfall in wheat procurement likely,' Commerce, CXXVI, 3237, May 19 1973, p 1013. Although the price of rice increased by 9 per cent in Andhra Pradesh during this period, market arrivals of rice actually declined, ibid. For an analysis of the Government's agricultural price policy on procurement see Lele,U. Agricultural Price Policy,' EPW, IV, 35, Aug. 30 1969, pp 1413-1414; see also, Saran,R. 'Recent Changes in Food Policy,' ASI, XXVI, 5 Aug. 1971, pp 287-296.

namely the supply of fertilisers at cheap prices to farmers. This bottleneck can be removed only by the rationalisation of the fertiliser industry in India.[1] Unfortunately, there is no explicit statement of fertiliser policy to support the HYVP. Until the problem of fertiliser shortage was thrown into dramatic relief by the world oil crisis, the planners played the numbers game judging by the emphasis placed on forecasting demand for fertiliser.[2] These forecasts were based on recommended doses of fertilisers applied on farms in experimental stations and not those actually applied on farmers' fields. The gap between the physical conditions in the two situations is

1 We are discounting here the possibility of improving the terms of trade for agriculture by higher product prices. To incorporate this alternative would require a full consideration of the role of price policy in the context of technical change in agriculture. A good point of departure for such a study is Dantwala, M.L. 'Incentives and Disincentives in Indian Agriculture,' IJAE, XXII, 2 April-June 1967, pp 1-25. Chaudhuri, P. Aspects of Indian Economic Development, A Book of Readings, op.cit., pp 55-57, sums up the debate on the subject, while the following are a couple of recent contributions, Saran, R. 'Agricultural Pricing to Support New Strategy in Production,' ASI, XXVIII, 12, Mar. 1973, pp 823-825; Krishna, J. 'Agricultural Prices-Problems and Policies,' IJAE, XXVII, 2, April-June 1972, pp 76-81.

2 The Government of India is not alone in playing the numbers game. The World Bank in its study, Effective Demand for Fertilisers in India (see page 120 above) has indulged in a similar pastime. For a trenchant criticism of the results and the methodology of the study see Shourie, A. 'Demand for Fertilisers: the Inhibition of Numbers,' EPW, VII, 31-33, Special Number, 1972, pp 1629-1632. As the burden of the article is the futility of making aggregate demand forecasts, the title of the article appears to be a bit of a misnomer. Perhaps it is more appropriately entitled, 'Demand for Fertilisers: the Fetish of Numbers!'.

so wide as to make nonsense of consumption targets. Given the inadequate distribution machinery, the talk of slowing down of fertiliser consumption in the late sixties was to perpetrate the idea that farmers used recommended doses when in fact they did not. We can only conclude that past estimates of total fertiliser requirements were unrealistic and not enough was done to examine the determinants of the demand for fertilisers at the micro-level. This is not to suggest that demand forecasts are unnecessary. These are necessary but extremely difficult to make. This is particularly so on the fertiliser industry in which the gestation period is long and the state of demand when the project comes on stream must be stabilised. It is here that both the cooperatives and extension agencies have to make the maximum contribution: the former by providing timely supplies of inputs and the latter by educating farmers in their correct application. Statistical forecasts must follow, not precede the identification of the real factors that determine fertiliser consumption - factors which this chapter set out to discover.

Conclusion

In this chapter we showed how the importance of fertilisers in the Higher-Yielding Varieties Programme derives both from the varietal characteristics of the new seeds and the poor quality of rice soils. In outlining the economic dimensions of this input we first analysed the demand for fertilisers at the micro-level. Although theoretically the demand for fertilisers depends on the profitability of their use as determined by the marginal product and cost-price ratio, we did not attempt to derive demand schedules based on economically optimum levels of fertilisers because of the lack of data for such calculations. Instead, we examined closely factors determining actual trends in consumption on our sample farms and in the state as a whole. We noted a divergence between actual levels of fertiliser use and recommended levels. We found the reasons for this divergence to be the non-availability of credit, shortcomings in the distribution of fertilisers by cooperatives and high fertiliser prices resulting from overall shortage of domestic production. We noted also the interaction between factors influencing demand for fertilisers and size of farms on the one hand and tenurial arrangements on the other. No definite pattern emerged from this interaction. As fertilisers are indispensable in the cultivation of higher-yielding varieties of rice we concluded that the latter will help increase rice output only if fertilisers are produced cheaply by the rationalisation of the fertiliser industry.

CHAPTER FOUR

EMPLOYMENT ASPECTS OF THE HIGHER-YIELDING VARIETIES OF RICE

The purpose of this chapter is to examine the hypothesis that the cultivation of higher-yielding varieties of rice will increase the demand for labour in West Godavary. It is claimed that these varieties will increase the technical capacity of agriculture to absorb labour in a productive way.[1] The analysis is limited to the estimation of the effect of HYV on the demand for labour.

The analysis of the demand for labour for the cultivation of HYV is in terms of the differences in the labour requirements of traditional varieties and the new varieties. No attempt is made to relate the estimated increases in demand to the supply of labour, because the problem of identifying labour requirements will become "empirically intractable" once the notion of elasticity of supply is introduced.[2] A further disclaimer is that no attempt

1 "The technical capacity of agriculture to absorb labour in a productive way is seen in some quarters as the central problem determining the ultimate demand for and supply of farm labour, at least in the near future for most of the contemporary developing countries." Ishikawa, S. Economic Development in Asian Perspective, Economic Research Series No.8, the Institute of Economic Research, Hitotsubhasi University, Tokyo, 1967, p 216.

2 Bhagwati, J.S. & Chakravarty, S. 'Contributions to Indian Economic Analysis,' op.cit., pp 2-73.

is made to relate our analysis to the discussions on the problem of unemployment in agriculture. These discussions have been primarily concerned with the nature and magnitude of disguised unemployment.[1] As the question whether there is too much labour available in relation to the demand for labour can only be answered after a careful examination of the employment of labour at the micro-level,[2] it is legitimate to set aside the immense intellectual effort spent on the measurement of disguised unemployment. As Myrdal has observed, the explanation of the difference between the labour reserve and the readily available supply in S. Asian countries "has to be studied realistically as a functional relationship between policy measure and labour utilisation during a period of time and in a particular situation."[3]

The estimates of labour demand made in this chapter are mainly based on the actual labour utilisation per acre in the cultivation of traditional varieties and HYV on our sample farms. This is presented by a detailed analysis of labour utilisation in rice cultivation based on FMS data. Section IV.1 deals with a consideration of the physical factors

1 For a summary of the debate see Eicher, C. & Witt, L. Agriculture in Economic Development, McGraw Hill Book Company, 1962, especially chapter on 'Disguised Unemployment in Agriculture : A Survey,' pp 129-144.

2 The need for a careful investigation of the institutional structure in which labour surplus is assumed to inhere is because of the "inconvenient form" in which the labour surplus exists (in the sense of a man being underemployed and yet not being available for employment) is due both to both the physical factors that govern agricultural production and the socio-economic factors that govern agricultural production and the socio-economic factors that govern the division of labour and the coordination of the labour effort of the community as a whole.

3 Myrdal, G. Asian Drama, An Enquiry into the Poverty of Nations, Vols. I-III, Penguin Books, 1968, p 1012.

responsible for the increased labour requirements of HYV, followed by a brief survey of the estimates of labour requirements made so far by other workers on the subject. Section IV.2 describes some earlier estimates of labour requirements of HYV. Section IV.3 examines the composition of Rural Households in West Godavary with regard to family labour and hired labour. Section IV.4 contains our estimates of labour requirements for traditional and HYV rice. It also explains the estimation methods adopted by us.

IV.1. Factors Responsible for the Employment Potential of HYV

Expectations regarding the greater labour absorptive capacity of rice are based on the intensification of crop production that their cultivation entails. The higher yielding capacity of these varieties will not materialise unless accompanied by improved cultural practices.[1] The latter refers to the simultaneous application of cultural practices such as line sowing, proper spacing, liberal and judicious use of fertilisers and manures, controlled irrigation and the use of plant protection measures.[2] Such methods are not new in India, because the Japanese method of cultivation, the epitome of intensive cultivation, was introduced in India as long ago as 1953-54. Some processes of rice cultivation that are likely to absorb more labour as a result of the cultivation of the new seeds are discussed briefly. But first, we give the distribution of the total working days of human labour in rice cultivation by type of work in West Godavary.

1 Hopper,W.D. 'The Mainsprings of Agricultural Growth,' Rajendra Prasad Memorial Lecture delivered at the XVIII Annual Conference of the Indian Society of Agricultural Statistics, reprinted in Khusro, _op.cit._, p 116. Experiments conducted at selected centres under Model Agronomic Scheme of the India Council of Agricultural Research showed how the adoption of improved cultural practices (line-sowing, intercultivation plant protection measures), resulted in yields over and above that obtained by the application of fertilisers alone. Government of India Ministry of Food and Agriculture, Directorate of Economics and Statistics, _Report on the Estimation and Assessment of Production Potential of Crops_, 1966 (date of printing) p 19-20.

2 For a description of this method see Ghosh,R.L.M., Ghatge,M.B. and Subrahmanian,V. _Rice in India_, Indian Council of Agricultural New Delhi, 1960, p 273-277. An earlier reference to the possibilities of increasing rice yields by means of improved seeds, manures and plant protection measures can be found in Burns,W. _Technological Possibilities of Agricultural Development in India_, Lahore, 1944.

Table IV.1 Distribution of Human Labour Operation-Wise
Irrigated Paddy (First Season Crop)
West Godavary 1959-60

Operations	Human Labour	
	Number of man-days per acre	As percentage of total number of man-days per acre
Ploughing	4.61	11.71
Manuring	1.34	3.40
Bunding	2.28	5.79
Transplanting	8.20	20.83
Irrigation	0.77	1.96
Weeding	5.21	13.23
Harvesting	8.67	22.02
Threshing	8.24	20.93
Miscellaneous	0.05	0.13
Total	39.37	100.00

Source: Government of India, Ministry of Food and Agriculture, Directorate of Economics and Statistics, Studies in the Economics of Farm Management, West Godavary (Andhra Pradesh), 1959-60, New Delhi, 1968, p 219.

Of all the operations in rice cultivation, transplanting, threshing and harvesting are the major ones accounting for 63.78 per cent of the total human labour input.[1] The percentage distribution of total human labour input among different operations is the same for all size classes of farms, Table IV.2. Increases in total labour input per acre due to the cultivation of the new varieties are expected to come about as a result of increases in labour input by type of operation. Four operations are singled out for illustrating this point. They are transplanting, interculturing, irrigation and harvesting.

There is considerable evidence to show that transplanted paddy is superior to broadcast paddy in terms of yield even in the case of the old varieties.[2] In the case of traditional varieties, transplanting has another function. Like continuous submergence, transplanting is a technique for controlling weeds.[3] The new varieties require additional measures of weed control, for, unlike the old varieties where the length of straw and

1 The operation-wise distribution of labour is corroborated by the Second Agricultural Labour Enquiry, Government of India, Ministry of Labour and Employment, Agricultural Labour in India Report of the Second Enquiry, 1956-57, Vol. I (All-India) 1960 pp 92-93. The intensive nature of rice cultivation can be judged from the proportion of total labour units employed per acre in the different cultural operations. In Japan, field preparation and inter-culture and weeding accounted for 17.3 per cent and 15.6 per cent of the total labour units applied per acre, per day. Contrast this with the situation in West Godavary, where ploughing and manuring taken together accounted for only about 15 per cent of the total amount of labour-units per acre. Similarly, whereas irrigation accounted for 8 per cent of the total time per acre in Japan, in West Godavary it was only 2 per cent. For the breakdown of labour requirements by operations in Japan, see Ranatung et.al., 'Labour Requirements for Rice Cultivation,' Tropical Agriculturist, CX, 4, Oct.-Dec. 1954, p 256.

2 Grist,D.H. Rice, Longman, 4th Edition, 1965, p 137; Ramiah,K. Factors Affecting Rice Production, Food and Agricultural Organisation, Agricultural Development Paper, No.45, 1945. Ramiah showed that in India, increases in yield due to transplanting is about 15-30 per cent; see also, Ghosh, Ghatge and Subramanian, Rice in India, op.cit., p 202. Transplanting is an arduous task and is mostly done by women. It requires 6-10 days to complete an acre, Grist, op.cit., p 143.

3 These are two examples of the ecological methods of weed control where the field environment is made unsuitable for the growth of weeds. Other methods are weeding by hand and chemical weed control.

Table IV.2. Distribution of Human Labour (Man days) per acre of Irrigated Paddy according to Operation, first season crop

Farm size group (acres)	Ploughing	Manuring	Bunding	Transplanting	Irrigation	Weeding	Harvesting	Threshing	Miscellaneous	Total
1	2	3	4	5	6	7	8	9	10	11
0.01 - 1.25	4.27	3.41	1.53	9.60	0.85	5.80	8.57	9.63	-	43.66
1.26 - 2.50	5.08	1.73	1.92	9.33	1.05	4.88	9.80	10.92	-	44.71
2.51 - 5.00	3.90	1.57	1.42	8.87	0.71	4.03	7.56	8.57	0.08	36.71
5.01 - 7.50	3.56	0.52	1.37	8.03	1.14	4.27	7.42	5.78	-	32.09
7.51 - 10.00	4.44	1.06	2.22	7.18	1.09	4.24	8.68	6.76	-	35.67
10.01 - 15.00	3.91	1.90	1.98	8.47	0.16	4.09	6.41	5.65	-	32.57
15.01 - 20.00	4.90	-	0.44	8.86	-	1.56	5.27	6.22	-	27.25
Above 20.00	5.24	1.30	3.12	7.87	0.94	6.77	10.39	9.82	0.09	45.54
All farms	4.61 (11%)	1.34 (3%)	2.28 (5%)	8.20 (21%)	0.77 (2%)	5.21 (13%)	8.67 (22%)	8.24 (21%)	0.05 (0%)	39.37 (100%)

Source: Studies in the Economics of Farm Management West Godavary (Andhra Pradesh) op.cit., p 220 mutual shading compensated for poor weeding, the new varieties need aid to enable them to dominate weeds.[1] Estimated yields of rice could be reduced up to 40 per cent in some cases if weeds are allowed to grow unrestricted.[2] Although the importance of weed control was recognised by the cultivators of the old varieties, the use of effective methods of weed control was not universally adopted. Weeding was done once or twice during the season, but no interculturing was given.[3] Traditionally, weeding has been done in India by hand, but in the past twenty years an ever increasing range of chemical herbicides have been available.[4] Not much information is available, however, on the extent of their use, and especially on the economics of their application, and what information exists refers to

1 The high fertility conditions under which the HYV grow are conducive to the growth of noxious weeds. Jennings,P.R. and Johnson,L. 'Breeding for Improved Rice Production,' Mechanisation and the World's Rice, op.cit., p 61.

2 Seeds of Echinochloa, the worst weed of rice is more effective in taking up nitrogen and phosphate from the soil than the rice crop. Wrigley,C., 'Modern Herbicides in Rice Cultivation,' ibid., p 92. The control of weeds is important not only in paddies, but also in the irrigation canals. It was found that in a large scale irrigation scheme in India, submerged weeds cut the flow of water by 80 per cent. Wrigley,G. 'The Problem of Weeds in Rice,' in Rice, Technical Monograph Number 1, Ciba Agro-chemicals Division March 1969, Basle p 29. In a study of rice cultivation in East Pakistan, Alim has shown that if rice is weeded three times instead of once, yield increases by 75 per cent. Alim,A. 'Rice Cultivation in East Pakistan,' cited in Wellisz,S. 'Dual Economies, Unemployment and the Supply of Labour,' Economica, New Series, XXXV, 137-140, 1968, p 22-51.

3 Ghosh,R.L.M., Ghatge,M.B. & Subrahmanian,V. op.cit., p 275. Interculturing means the stirring of the soil between the plants to a few inches in order to aerate the roots and this helps remove weeds.

4 Ibid., p 208.

experimental data. Trials are being conducted by the Central Rice Research Institute to determine the judicious combination of chemical-cum-cultural methods of weed control, the idea being to reduce the intensity of weed infestation by one of the cheap chemicals, and then controlling the remaining weeds either chemically or by hand.[1] The importance of hand weeding can be gathered from this; unless cheap chemicals are made available to the farmers, weeding by hand will be the chief method of weed control in rice cultivation for some time to come.[2] Some measure of the labour required if rice is weeded by hand rather than mechanically or chemically can be had from Table IV.3. All this is some evidence that weeding and interculturing operations that must accompany the cultivation of HYV will lead to higher labour requirements.

1 Neither the Report on the HYVP nor the reports of the Programme Evaluation Organisation refer to the role of herbicides in the new strategy. Interculturing is mentioned in general terms, Government of India, Ministry of Food, Agriculture, Community Development and Co-operation, Report on the Higher-Yielding Varieties Programme, Studies in Eight Districts, Kharif, 1966-67, New Delhi, 1967, pp 8-9.

2 Indian Council of Agricultural Research, Technical Report of the Central Rice Research Institute for the Year 1966, Cuttack, 1970, pp 17-19. Labour required for weeding operations by hand occupies, in some instances, up to 25 per cent of the total number of man-hours involved in rice culture. Garrard, N.M. 'Paddy Rice Production,' in Mechanisation and the World's Rice, the proceedings of a Conference to Support the International Rice Year, 1966, of the Food and Agricultural Organisation of the United Nations organised by Massey-Ferguson, England, 26 Sept.-1 Oct., 1966, p 53.

Table IV.3. Labour Requirements for Weeding According to Different Methods of Weed Control

Treatment 1	Time of Treatment (Days after Transplanting) 2	Weeding Time Man Hours/acre 3	Rice Yield lbs per acre 4
Hand-weeded twice	(1) 20 (2) 40	1522	4652
Hand-weeded once	30	798	3685
Single Rotary Weeding	30	375	3502
Rotary Weeding	20	909	3999
Hand-weeding	41		
MCPA[1] (0.894 kgs per acre)	20	257	3732
Rotary Weeding	41		

Source: Results of the Weed Control Experiment at the International Rice Research Institute, cited by Wrigley,G. 'The Problem of Weeds in Rice,' op.cit., p 27. The variety referred to in this case is Chianung 242 with a severe infestation of Echinochloa crus-galli, ibid., p 28.

1 MCPA is the name of one of the many weed killers, namely, Phenoxylene-30. As regards the effect of herbicides on paddy yield, the merit of hand weeding was second only to the application of MCPA, Technical Report of the Central Research Institute for the Year 1966, op.cit., p 17 (Variety - Tainan - 3). In the IRRI experiment mentioned above, hand-weeding twice after transplanting produced the highest yield.

We noted in Chapter II that as rice is a Kharif crop, water management is important. The essential factor determining a bumper or a poor crop is the availability of adequate and timely supplies of water. The complementary nature of fertiliser and irrigation inputs and the need for controlled application of water give new dimensions to the problem of irrigation. Irrigation of new varieties requires considerable care with regard to the timing and the quantity of water. This factor is expected to increase the number of man-hours or man-days spent in the cultivation of new varieties. Increased labour requirements is also expected to flow from the higher intensity of cropping that irrigation makes possible. Additional labour requirements are also seen to arise from the practice of multiple cropping which is made possible once water supplies are adequately available.

Labour requirements in terms of man-days per acre depend upon the technique of irrigation. Manual labour for lifting water from surface wells is higher than that required when irrigation is by means of canals. For instance, in the districts of Salem and Coimbatore in Tamil Nadu where irrigation is by means of wells, 42 per cent of the total amount of time spent by family labour per acre was spent on irrigation.[1] In West Godavary, however, only about 2 per cent of the total time was spent by total labour (family and hired) on this operation.[2] Labour requirements in the case

1 Government of India, Ministry of Food and Agriculture, Studies in the Economics of Farm Management, Madras, 1956-57, New Delhi, pp 143-147.

2 See Table IV.1 above.

of mechanised pumps are likely to be lower than the requirements for the two techniques mentioned above. In estimating increases in labour requirements brought about by the cultivation of HYV one could either take a narrow view of irrigation as the application of water periodically, once the crop is sown or one could consider the whole range of operations that constitute land preparation such as ploughing, harrowing and puddling. If we take the latter view, then, the high quality of land preparation that is required to cultivate the new seeds successfully, will require additional effort and therefore more man-days per acre in the absence of mechanisation.

Among the various operations involved in rice cultivation, harvesting assumes special importance in the growing of HYV. Apart from the problem of handling the increased bulk of the crop, the timing of harvest is important and along with sowing operations accounts for the seasonal bulge in labour requirements.[1] Harvesting involves several operations, all of them labourious. They are cutting, collecting the grain, transporting to the threshing area, threshing, etc.[2] If harvesting is delayed, either losses occur through shattering due to extreme dryness, or the onset of rains will lead to a wet harvest. While a small labour force can harvest a given area in some maximum time, say 30 days, the quantity and quality of harvest will be inferior to one carried out by a larger labour force in half the

1 The data on hand do not allow us to quantify the nature of the seasonal bulge in labour requirements. As the FMS for West Godavary does not show the deployment of labour in the different operations of rice cultivation according to the type of labour, even an indirect estimate, such as one can make in the case of the FMS for Madras cannot be made. The reliance of hired labour for sowing and harvesting in Madras can be inferred from the relatively longer time hired labour spent on these operations compared to family labour. Whereas hired labour spent 24 per cent and 34 per cent of the total number of days on sowing and harvesting, respectively, family labour spent only 8 per cent and 14 per cent on the same operations, Studies in the Economics of Farm Management, Madras, 1956-57, op.cit., pp 143 & 147.

2 Grist, Rice, op.cit., pp 146-147; Foster, S. 'Mechanical Harvesting,' in Mechanisation and the World's Rice,' op.cit., p 94.

time.[1] If grain is harvested after the onset of rains, provisions have to be made for drying and storage. This is particularly important in the case of the new varieties as they germinate more quickly than traditional varieties. Mechanical drying is a pre-condition for the practice of multiple-cropping in these circumstances. Recognising the importance of this, the Food Corporation of India set up 30 mechanical dryers, each with a capacity of 160 tonnes of paddy per day in various parts of the country. Mechanical drying also improves the milling qualities and helps recover a higher percentage of grain.[2]

Unlike sowing where a limited amount of mechanisation has taken place to break the labour bottleneck, harvesting of rice in India continues to be done by hand.[3] This is because, harvesting is the more difficult operation in the growth cycle to mechanise on account of adverse soil conditions.[4] The range of machinery for this purpose is limited and one notices its virtual absence in the inventory of farm machinery in India.[5] Successful

1 Bhattacharya,S. Mechanisation of Agriculture in India, Vishwabharati Publications, No. 7, 1949, p 31.

2 Anon., 'Mechanical Paddy Dryers,' EPW, IV, 11, March 1969, p 498.

3 This situation is very different from that in Punjab where labour shortage and high agricultural wages has led to the adoption of mechanical threshers, Billings,M.H. and Singh,A. 'Labour and the Green Revolution,' EPW, IV, 52, Dec. 27, 1969, pp A221-A224; Bardhan,P. 'Green Revolution and Agricultural Labourers,' EPW, V, 29-31, July 1970, pp 1239-1246. The daily agricultural wage rate for harvesting in Punjab was higher than in Andhra Pradesh by almost 200 per cent (in 1971) and what is more, whereas during the period Oct. 1971 - July 1972 it rose by roughly 33 per cent, the rate in Andhra Pradesh during the same period was stable, see Agricultural Situation in India, XXVII, 2, 3, 4, May-July 1972, 10, 11, 12, Oct.-Dec. 1972 and XVIII, 2, 3, 4 May-July 1973, pp in order of numbers of vols. : 137, 205, 274, 710, 799, 894, 125, 187 and 264.

4 Even in Japan mechanisation of threshing followed that of tilling operations, Raj,K.N. 'Mechanisation of Agriculture in India, and Sri Lanka (Ceylon),' in Mechanisation and Employment in Agriculture-case studies from four countries, International Labour Office, Geneva, 1973, p 114; see also Ishikawa,S. Economic Development in Asian Perspective, op.cit., p 245.

5 In a district-wise study of the use of modern machinery in India during the Second Plan period there is no mention of mechanical harvesters of any sort, Sarkar,K.K. 'Growth of Farm Machinery in India,' ASI, XXIII, 7 Oct. 1968, pp 677-683.

mechanical threshing of rice must await further improvements on machines like the combine harvester, for this machine, the ultimate in mechanical harvesting, was developed as a dry cereal machine and cannot be used on wet fields, especially in the tropics without modifications.[1] What is more, in the harvesting of the new varieties, additional problems are encountered because further genetic improvements have to be made to facilitate mechanical harvesting. These refer to traits like threshability and safeguards against shattering of grain.[2]

Finally, increased labour requirements in the cultivation of HYV are expected to arise from the need to control pests and diseases. The high fertility conditions that govern the growth of the new plant types help breed insect population and increase opportunities for the spread of diseases. To prevent potential losses[3] in yield there must be constant control of pests and parasites. Plant protection measures are assumed to call for greater labour effort. The problem of pest control is particularly important in the case of HYV rice, because diseases like bacterial blight are most destructive in double-cropped area. The reason for this is that on account of successive cropping without a break, these diseases become cumulative and a heavy load of inoculum is readily available for the new crop from the previous one.

1 Low,J.R. 'Rice Mechanisation,' in Rice, Technical Monograph 1, Ciba, op.cit., pp 18-19. Attempts are, nonetheless, being made to develop mechanical harvesters. The John Deene self-propelled combine harvester meant primarily for wheat is being adapted for rice harvesting. On the basis of a study carried out by Wilcox, Buckwell, India Ltd. the per acre cost of harvesting can be reduced to less than Rs 65 per acre after taking into account all operational costs, Anon., 'Mechanised Harvesting,' EPW, IV, 19, May 10, 1969, p 802. Similarly,modifications are being made to wheel tractors imported from the USSR. Although, initially these were considered suitable only for dry cultivation, in recent years they have been used in wet cultivation by using side-caged wheels instead of rubber tyres, see Srinivasan,N. Agricultural Administration on India, op.cit., pp 289-290.

2 Barker,R. 'The Evolutionary Nature of the New Rice Technology,' op.cit., p 124.

3 In India, every year 10-15 per cent losses in yield are caused by plant diseases. During epidemics, the damage could be as high as 50-90 per cent, Ghosh,Ghatge & Subramanian, Rice in India, op.cit., p 67.

Bacterial blight has been found to be particularly acute in the intensive rice areas of South India.[1]

Ideally, the breeding of high-yielding disease resisting varieties is the best method of combating diseases of the rice plant and attacks from pests. But plant breeding is not the panacea for these problems because one can envisage an endless race between the plant breeders producing new disease-resistant varieties and the disease producing new strains against which the new varieties are not resistant! Besides, the development, multiplication and distribution of new varieties is an expensive process.[2] Other methods of disease and pest control are chemical and cultural. The first refers to the use of pesticides and the second to a variety of cultural operations like burning of stubble to destroy hibernating larvae, collection of egg masses and the careful selection of seedlings.[3] Due to externalities, chemical control of pests and diseases by farmers individually is regarded as being an uneconomic method of plant protection.[4] It is for this reason that such measures have been

1 Rayachaudhuri, S.P. 'Diseases of Rice and Wheat, Problems in an Intensive Area, IF, XX, 7 Oct. 1970, p 33. Further evidence on the build-up of pests and diseases on account of double-cropping can be found in Grist, op.cit., p 157 and Hopf, H.S. 'Rice Pest and Disease Control,' in Mechanisation and the World's Rice, op.cit., pp 86-91. The high susceptibility of HYV to diseases was highlighted recently when there was a severe outbreak of tungro virus disease in ten Phillipine provinces, Financial Times, 18.8.1971.

2 Indian Council of Agricultural Research, Technical Report of the Central Rice Research Institute for the year 1966, p 88. However, research into the biological methods of controlling pests and diseases is currently receiving the main emphasis at the International Rice Research Institute, Financial Times, 14.7.1971.

3 Lever, R.S.A.W. 'The Current Position of the Control of Rice Diseases,' Rice, Technical Monograph 1, Ciba, op.cit., pp 32-38.

4 Johnson, A. 'Chemicals for the Control of Rice Diseases,' ibid., pp 20-26. For a study of the pattern of use of pesticides see Desai, G.M. 'Factors Determining the Demand for Pesticides,' EPW, V, 52, Dec. 1970, pp A181-A183; see also Ghosh, Ghatge & Subramanian, Rice in India, op.cit., pp 269-272.

carried out by various Extension Officers of State Agricultural Department.[1] In these circumstances measures of plant protection undertaken by individual farmers will consist of cultural methods of disease and pest control and these are likely to be more time-consuming than either of the other two methods.

It is these characteristics of the new varieties that have led several economists to believe that their cultivation will absorb a high proportion of the labour force in rural areas. Galenson has observed that there is probably no recent agricultural development with a greater potential for affecting employment, but as yet it is impossible to predict in what direction.[2] The difficulty with assessing the direction of employment may be ascribed to the comparatively recent implementation of the new strategy and the unsatisfactory state of the data on labour utilisation in crop production. Also, in assessing the employment effect of HYV we have to take into account some countervailing forces like mechanisation. The scope for additional employment as a result of growing the new seeds on a large scale will be determined by a large number of forces, both technical and socio-economic. Mechanisation of rice cultivation can be said to embody these forces and its effects on employment is discussed at the end of this chapter.

1 For an appraisal of plant protection measures undertaken by various official bodies, see National Council of Applied Economic Research, Pesticides in India, New Delhi, 1967, pp 57-70; see also, Fourth Five Year Plan, op.cit., p 134.

2 Galenson, W. Essays on Employment, International Labour Organisation, 1970, p 7. More confidently Brown observes : "Where ever data are available they indicate that the new seeds require more labour than the traditional ones they replace". Brown, L.R. Seeds of Change, op.cit., p 104. Elsewhere Brown refers to the fact that the total demand for labour (family and hired) may be as much as 60 per cent greater than in the case of traditional varieties, The Social Impact of the Green Revolution, International Conciliation, Published by the Carnegie Endowment for International Peace, No. 581, Jan. 1971, p 24.

IV.2. Estimates of Labour Requirements of HYV

Estimates of labour requirements of the new varieties have been derived largely on the basis of projection models based on assumptions concerning the rate and spread of their cultivation, rate of fertiliser use, etc. The study by Johnston and Cownie and the Indicative World Plan proposals belong to this category.[1] The former does not spell out labour requirements but merely develops some indeterminate policy implications of the seed-fertiliser revolution. According to the Indicative World Plan proposals, intensification of agriculture will increase employment per family from 227 man-days in the base year (1962) to 261 in 1985, an increase of 15 per cent.[2] Although the latter study employed a high degree of aggregation, the methodology employed to arrive at the estimates is worth spelling out in some detail because it is similar to the basis of our own calculations.

The methodology consisted of three steps: calculation of actual labour employed in crop production in base year (1962); estimation of labour requirements in year 1985 based on Indicative World Plan proposals and finally analysis of the implications of changes in agriculture and the productivity of labour. Whenever possible a distinction was made between irrigated and non-irrigated crops. Adjustments were also made to accommodate differences in planting of crops like broadcasting and transplanting. The per hectare requirements of labour was multiplied by the area under each crop in the base

1 Johnston, B.F. and Cownie, J. 'The Seed-Fertiliser Revolution and the Labour Absorption Problem,' American Economic Review, LIX, No. 4, Part I, September, 1969, pp 569-582.

2 Food and Agricultural Organisation of the United Nations, Provisional Indicative Plan for Agricultural Development, Rome, 1969, p 58.

year and totals for each crop were added to get the national average. The labour requirements for 1985 were estimated on the basis of areas seeded to the new varieties. To reflect the higher labour requirements in operations like weeding and harvesting, weights in the form of harvest labour to total labour were used in the calculation of labour elasticities. These ranged from 0.25 to 0.6. The new labour requirements per hectare were then calculated by multiplying out by the area under crops. Mechanisation discounts were applied in a similar way. The area covered by mechanisation was estimated from the mechanisation proposals of the Plan and an adjustment factor ranging from 20-35 per cent was assumed according to the nature of the crop grown. The weight applied to rice was low. Finally, to derive the average labour days required per household, total labour requirements were divided by the estimated number of agricultural households.[1]

One of the earliest attempts at setting up a physical projection model using dis-aggregated data, albeit, to study labour requirements for wheat was made by Billings and Singh.[2] They estimated the quantitative impact of new varieties on human and animal labour requirements. The cultivation of new varieties of wheat increased demand for human and animal labour by over 6 per cent over the whole year and had the effect of shifting the peak demand from October to November. Pumpsets, threshers and tractors reduced labour requirements by 4 per cent, 5 per cent and 3.5 per cent respectively. The overall demand for labour was estimated to suffer a reduction of 13 per cent in 1973 compared to the peak level of demand in 1968-69.[3]

1 Information from various sources was used for estimating the base period labour requirements, crop by crop, for India, Ceylon, Pakistan and Thailand. Details of the methodology given above are contained in an Internal Secretariat Working Paper entitled, A Note on Employment for Indicative World Plan Study (Office Memorandum dated May 20 1969).

2 Billings,M.H. & Singh,A. 'Labour and the Green Revolution,' EPW, IV, 52, Dec. 27 1969, pp A221-A224; also 'Mechanisation and Rural Employment - Some Implications for Rural Income Distribution,' EPW, V, 26, June 1969, pp A61-A72, by the same authors. Other studies using disaggregated data are available but they refer largely to labour absorption of new wheat varieties.

3 Billings & Singh, 'Mechanisation and Rural Employment - Some Implications for Rural Income Distribution,' op.cit., p A221-A224.

These estimates of labour requirements for wheat have been described in some detail because in the absence of similar ones for rice, they give an idea of the aspects of the labour absorption problem. There are reasons to believe that labour requirements will be proportionately higher for new varieties of rice than those of wheat. As we argued earlier, wheat cultivation lends itself more readily to mechanisation than rice cultivation does.[1] Furthermore, cultural operations have a greater effect on the yield of rice than on the yield of wheat and therefore increased labour demand can also be expected on this score.[2] Confirmation of this view can be had from some of the new available estimates of labour requirements for rice.

Reports of the PEO and on the progress of HYV and the Report on HYVP, Studies in Eight Districts are the chief sources of information on labour requirement of HYV rice. However, the estimates here are not given in man-days but have to be inferred from expenditures in cash and kind on hired labour. Such inference is not legitimate as we do not know the wages paid to hired labour.[3]

1 Difficulties in mechanising rice cultivation have been referred to earlier. The problems associated with mechanisation of rice cultivation are discussed at the end of this chapter.

2 Government of India, Planning Commission, Report on the Estimation and Assessment of Production Potential of Crops, New Delhi, 1966, p 19.

3 No attempt is made here to derive the actual number of man-days spent on the farms by hired labour from the PEO reports on HYV. The effort required to get the average wage rate for the districts growing paddy in the different years is out of all proportion to the extent of use we wish to make of labour requirements derived from this source.

The hypothesis of increased labour requirements can be tested by looking at the movement of wages of agricultural labour. There is some evidence to show that wages in Punjab have gone up since the advent of HYV wheat. Bardhan has shown, however, that it is misleading to go by the movement of cash wage rates.[1] His study of the data for north-west India showed that the increase in cash wages rates during the sixties was accompanied by a sharp rise in the cost of living index. Accordingly, he argued that any assessment of the relative improvement in the incomes of agricultural labourers must be based on both real wage rates and other information on actual employment. This implies that increases in employment will have to be measured independently. The need for direct estimates of employment and unemployment was also urged by Raj Krishna at the conference on Labour Markets in Rural Areas organised by the Indian Society of Agricultural Economics in 1970 on the grounds that the empirical evidence to support claims of increased demand for labour as signified by increases in wage rates was lacking.[2] Like Bardhan, he was forced to make this observation on the basis of the peculiar results obtained when money wages was converted into real terms.

Before leaving the description of the official sources of information on labour requirements another shortcoming of this source must be noted. This is, no information is given on the contribution of family labour. The Report on the HYVP does not give any reason for the exclusion of family labour. We do not know whether the Technical Committee set up to report on the HYVP

1 Bardhan, P.K. 'Green Revolution and Agricultural Labourers,' EPW, V, 29, 30 & 31, July 1970, pp 1239-1246.

2 Rapporteur's report, Annual Conference of Agricultural Economics on Labour Markets in Rural Areas held in Pantnagar, Oct. 23-25, 1970 in IJAE, XXV, 3, July-Sept. 1970, pp 15-16.

was thwarted by the problem of imputing values for family labour.[1] While the avoidance of the temptation to impute values is admirable in itself, in the face of the extreme paucity of information on farm inputs the opportunity of recording labour inputs in physical units seem to have been missed. While the first Technical Report on HYVP was a hurried job done at the request of the Reserve Bank of India, it is a little distressing to note that the PEO in its subsequent reports followed the same method. Short of Farm Surveys, on the lines of Farm Management Studies, but this time dispensing with the need for imputing values, our knowledge of the actual utilisation of labour on farms will be incomplete.[2]

1 The values of all self-supplied imputs are imputed in the FMS. The need for imputation arose in these Surveys because they were primarily concerned with judging the profitability of farms. Sen was among the first to point out how this technique has bedevilled attempts made to explain the inverse relationship between farm size and productivity, Sen,A.K. 'Size of Holding and Productivity,' <u>The Economic Weekly</u>, XVI, 5, 6 & 7 (Annual Number), Feb. 1964, pp 323-326. For an early critique of imputing values to family labour see Chaynov,A.V. <u>The Theory of Peasant Economy</u>, <u>op.cit.</u> According to Chaynov, in a peasant economy, which he regarded as being a system <u>sui generis</u>, the annual product minus outlays cannot be broken down into wages and other factor payments. Therefore, he saw no merit in circumventing the absence of wages by imputing wages to family labour. Chaynov also spoke of the inapplicability of the profit motive to peasant farmers, who, unlike the capitalist farmer are interested in securing the needs of the family and therefore put in only that amount of effort which is necessary for this purpose. This is his theory of labour-consumer balance. Chaynov's criticism applies essentially to peasant economies that do not hire labour. But one cannot argue that the mere presence of hired labour as in Indian agriculture justifies the need for imputation unless the object is to obtain an idea of the profitability of farms, an object the FMS clearly has. To criticise the preoccupation with profitability is not to imply that farmers in India are not profit-minded. To do this would mean the setting aside of a vast body of evidence supporting the price-elasticity of supply. The point being made here is that the preoccupation with profitability in the FMS detracts from their usefulness in depicting production relationships in agriculture. Perhaps the results of the first ever agricultural census held in 1971 will provide a better basis for the study of agricultural production relationships.

2 The need for measuring self-supplied inputs by techniques other than imputation is long overdue. The advocacy of this need can be likened to Rudra's plea to adopt the "material production method," to measure national product, Rudra,A. 'The Rate of Growth of the Indian Economy,' in <u>Economic Development in South Asia</u>, <u>op.cit.</u>, pp 38-53.

Despite the shortcomings of the official reports on HYVP, mention must be made of some of the estimates made on their basis. The National Commission of Labour[1] estimated that under the new strategy, an acre of land under the new seeds will provide 30 days of extra employment a year and an acre under intensive multiple cropping will provide 26 additional man-days of labour. Table IV.4 gives a few details of the findings of the Commission.

Table IV.4. Labour Requirements in Agriculture in Man-days

Region	Crops	Intensity of Cropping	Man-Days Local	Per Acre HYV
1	2	3	4	5
<u>Single Crop Cultivation</u>				
Cropping Intensity about 1				
Orissa (Sambalpur)	Paddy	0.92	43	63
W.Bengal (Hooghly & 24 Paranas)	Paddy/Jute	1.05	55	75
Maharastra (Ahmednagar)	Gowar/Bajra/Wheat	1.09	19	29
<u>Multiple Crop Cultivation</u>				
Cropping Intensity 1.5-2.0				
Punjab (Amritsar & Ferozpur)	Wheat/Wheat/Gram/Cotton	1.50	24	54
Andhra Pradesh (W.Godavary)	Paddy	2.00	97	137
U.P. (Meerut & Muzaffarnagar)	Wheat/Sugarcane	1.50	73	103
<u>Intensive Multiple Cropping with mechanisation</u>				
Cropping Intensity 2.0				
Punjab	Wheat/Wheat/Gram/Cotton	2.00	21	47
Andhra Pradesh	Paddy	2.00	72	98
U.P.	Wheat/Sugarcane	2.00	63	89

Source: <u>National Commission on Labour</u>, <u>Annexure III</u>, <u>op.cit.</u>, p 416

1 Government of India, Ministry of Labour, Employment and Rehabilitation, <u>Report of the National Commission on Labour</u>, New Delhi, 1969, p 398. The data for local varieties is based on FMS for the various states and the data for HYV from the cash expenditure on these varieties, presumably by dividing the total expenditure on hired labour by the wage rate.

By far the best use made of the data provided by the PEO has been by Lahiri, who calculated the actual number of man-days spent in the cultivation of the HYV by dividing the total cash expenditure on HYV for 1968-69 by the average of the daily wage rate for the year in each State.[1] The average hired labour requirement for HYV paddy in 1968-69 was 65 man-days compared to 30 man-days in the pre-HYV period, and 33 man-days for the cultivation of the local varieties in 1968-69. These figures are presented with some alterations in Table IV.5. These alterations have been made for the sake of uniformity.[2]

Table IV.5. Total Labour Requirements for Traditional & HYV Paddy-Kharif (in man-days per acre)

State	Traditional Varieties			HYV
	Family	Hired	Total	Hired
Andhra Pradesh (1957-60)	9	37	47	90
Kerala (1962/65)	1	63	64	60
Tamil Nadu (1954/57)	93	23	117	54
W. Bengal (1954/57)	30	19	49	157
Average	34	36	59	65

Source: Lahiri,R.K. 'Impact of Higher-Yielding Varieties Programme on Rural Labour Market,' EPW, V, 39, September 26, 1970. Tables I & II, pp A111 & A112.

1 Lahiri,R.K. 'Impact of Higher-Yielding Varieties Programme on Rural Labour Market,' op.cit., pp A111-A112.

2 As there were no comparable figures for HYV for the states of Bihar and Madhya Pradesh, they were dropped by us from Lahiri's Table 1. The averages for the traditional varieties have accordingly been raised.

To obtain the estimated increase in the demand for hired labour, Lahiri multiplied the per acre labour requirement by the total area under HYV of rice in 1968-69.[1] His estimate and our adjusted figures are given below in Table IV.6.

Table IV.6. Estimated Increase in the Demand for Hired Labour for HYV Paddy Cultivation in 1968-69. Average for Andhra Pradesh, Kerala, Tamil Nadu and West Bengal

	Labour Utilisation per hectare		Increases in Labour Utilisation	Area under HYV 1968-69 m.acres	Total Demand for Labour m.lab.days
	HYV	Local			
Lahiri's	65	30	35	6.4	224.00
Our's	65	36	30	6.4	192

Source: Same as IV.5.

Lahiri's estimates[2] are the best results achieved so far by combining the Farm Management Studies with the data provided by the PEO. The chief limitation of his study is that the estimates of labour requirements refer to the total area under a particular HYV cereal. As overall estimates have little

1 Lahiri, op.cit., p A112

2 Lahiri made estimates for five HYV cereals. The labour requirements for wheat are shown below in order to substantiate the claim made on p 32 that the labour requirements for rice are higher. Compare these figures with those for rice shown on p 37.

<u>Labour Requirements for Wheat (Local & HYV) Man-days per Acre</u>

State	Local Varieties			HYV
	Family	Hired	Total	Hired
Punjab (1954-57)	24	10	34	8
U.P. (1954-57)	21	6	27	28
Average	23	8	31	18

Source: Lahiri, <u>op.cit.</u>, p A112

relevance for policy making, these have to be substituted by the results of more disaggregated studies. Section 3 of this chapter seeks to estimate labour requirements per acre by size-class of farms in West Godavary.

Despite the claims made for the increased employment potential of the new varieties, it is curious to note that the employment generating aspects of the new varieties contained in the policy statement on HYV in the Fourth Five Year Plan runs along very general lines.

> " The increasing tempo of agricultural development in the Fourth Plan is expected to create new employment opportunities on a large scale in rural areas and also provide fuller employment to those already engaged in agriculture."[1]

By "increasing tempo of agricultural development" is meant the extension of area under cultivation, multiple-cropping, the cultivation of HYV, the expansion of minor and major irrigation works and the integrated use of surface and ground water.[2] In common with the previous plans, it is hoped to create employment in the rural areas by the adoption of strategies designed to increase crop production and those which seek to lay the infra-structure of agricultural development.[3] Programmes like the "Crash Scheme" to provide rural employment for 1000 people for ten months in the year for each district

1 Fourth Five Year Plan, op.cit., p 430.

2 Ibid.

3 While recognising the fact that there must be a balance between the growth of investment and development and the creation of employment opportunities, the Plans have sought to achieve this balance "as an indirect rather than as a direct consequence of planning". (The Fourth Plan - Draft Outline, p 106). The persistent refusal by the Planning Commission to face the employment problem directly is difficult to understand. Could it be that, as suggested by Sen, fear of inflation and an unmet rise in demand are the important factors explaining the reluctance to expand employment rapidly in the short run? Sen,A.K. 'Strategies of Economic Development, Feasibility Constraints and Planning,' in Economic Development in South Asia, Proceedings of a Conference held by the International Economic Association at Kandy, Ceylon, 1970: Edited by Robinson,E.A.G. and Kidron,M. Macmillan, St. Martin's Press, 1970, p 375; see also, Ovens,D. Investment in Human Capital, in Streeten,P. and Lipton,M. The Crisis of Indian Planning, OUP, 1968, pp 229.

have so far made very little impact on employment in the rural areas.[1] It could be argued that the non-recognition of the problem of employment as one that has to be solved directly has led both the central and state governments to ignore the need to appraise the employment potential of schemes at the disaggregated level. The need to do this was emphasised by the Committee of Experts on Unemployment Estimates.[2] The logic behind the Expert Committee's recommendation was that the character of employment and unemployment and the labour force in India in general was too heterogenous to justify the aggregation of these variables into "single dimensional magnitudes."[3] The Committee also suggested that attempts must be made to identify the demand likely to be generated for particular categories of labour as a result of schemes contained

1 Anon., 'Economic Survey, 1970-71,' Yojana, XV, 10&11, June 1971, p 8. It is not known to what extent the Rural Works Programme is successful in providing employment. According to Minhas unless such programmes are geared to consolidation and the realignment of property rights in land it is unlikely to absorb the productive capabilities of the small farmers, Minhas,B.S. Rural Poverty, Employment and Growth, Towards Social Justice Series, Ministry of Information and Broadcasting, Government of India, 1970, p 8. In some parts of India such works themselves have experienced shortage of labour, and this has been ascribed to the high reservation price of rural labour on account of institutional factors, Planning Commission, PEO, Report on Evaluation of Rural Manpower Projects, 1967, pp 15 & 34; see also Guha,S. Rural Manpower and Capital Formation in India, Academic Books, Bombay, 1969.

2 Government of India, Planning Commission, Report of the Committee of Experts on Unemployment Estimates, 1970, p 7. This was a committee set up by the Planning Commission to enquire into the methodology adopted to derive employment estimates in the previous Plans.

3 Ibid., p 31.

in development plans. Such efforts should be concentrated in areas where labour requirements could be observed accurately. The Expert Committee was sceptical how far this could be done. In making our estimates we are taking a step in this direction. Labour requirements in rice cultivation, thanks to FMS among other sources of information can be specified. The particular segment of the labour force we seek to study is the predominantly self-employed household enterprises. This is fraught with difficulties, because the intractability of the Indian agricultural labour force springs largely from the character of this particular sector.

The questions we set about answering are (1) will intensification of rice cultivation give fuller employment to labour force in the rural areas, and (2) how will the increase in employment get distributed among different sections of the labour force? It is easier to answer the first question than the second. The relative contributions of family and hired labour in meeting the increased labour demand on farms as a result of the cultivation of the new varieties are easily determined. What is indeterminate is the character of the pool of labour which will constitute the hired labour component. This is because it is composed of such occupational categories as owner-cultivators, tenants, share-croppers, unskilled rural labour and a floating section of the industrial labour force.[1] Furthermore, as we noted earlier, there is a

1 Government of India, Ministry of Labour, (First) Agricultural Labour Enquiry, <u>Agricultural Wages in India, Vol. I</u>, 1952, pp 27-28; <u>Report of the Second Agricultural Labour Enquiry</u>, <u>op.cit</u>., pp 36-37.

considerable overlap between size of holdings and alternative forms of land tenures. A measure of the difficulty in identifying the section of the rural population that hired itself out can be got from a brief digression on agricultural labour. This is useful as it enables us to arrive at the definition of labour input used in our estimate.

Workers in agriculture are commonly distributed among three classes, cultivators, agricultural labourers and those engaged in tending livestock and forestry. Agricultural labour in India is a special category of labour if such a category can be identified. It does not refer to labour in agriculture in the general sense. The two Agricultural Labour Enquiries and more recently, the National Commission on Labour refer to this class of labour as being basically unskilled and unorganised labour whose chief means of livelihood is their personal labour which they sell for wages. Agricultural labour is further divided into landless agricultural labour and cultivators who either own or rent small pieces of land. The income from the land being insufficient to live on, this category offers itself for wage employment.[1] Landless labour could refer to either permanent labour attached to farm

1 Much of the controversy regarding the improvement in the condition of agricultural labour in India between the First and Second Agricultural Labour Enquiries centres around the differences in the definitions adopted. According to the First Enquiry, "any person who worked as an agricultural worker for more than one-half of the total number of days on which he actually performed work during the year," was an agricultural labourer, Agricultural Wages in India, op.cit., p 11. The classification of the entire family followed that of the head of the household, ibid., p 10. The Second Agricultural Labour Enquiry defined an agricultural labour household as one "where the major part of the income was derived by members pursuing agricultural labour as their main occupation," Report of the Second Agricultural Labour Enquiry, p 3. This definition corresponds to the one adopted by the NSS which defined agricultural labour household as one for which wage employment fetched the larger share of income. This is understandable as this round was integrated with the Second Agricultural Labour Enquiry, ibid., p 1. See also Government of India, Cabinet Secretariat, National Sample Survey, Tables with Notes on Employment and Underemployment, Rounds XI and XII, August 1955-56, No. 52, New Delhi, 1961, p 2; refer also Appendix I.

households[1] or to casual labour. The latter could be drawn from any of the categories of labour mentioned earlier.[2] We see, therefore, that agricultural labour is not a homogeneous class. It is this category of labour that is referred to as hired labour.[3] Family labour and hired labour comprise the total labour force in the district under consideration. Before leaving this section, a final complication in the identification of hired labour must be noted. Wage employment is not the criterion adopted by the FMS for classifying hired labour. Hired labour refers to casual labour and as they do not participate in all the activities on the farm, they are treated as working capital.[4] Again, although annual servants are paid wages they are treated as family labour.[5]

It is the overlap between different classes of agricultural labour described in the previous paragraph that makes it difficult to identify the category of labour that gets employed. It is possible to speculate, however, that agricultural labourers without land and casual labourers are more likely

1 They are referred to as attached labour or annual servants in the FMS.

2 Refer page 184 above.

3 According to the Second Agricultural Labour Enquiry, all categories of agricultural labour (attached, casual, landless and those with land) spent 194.26 days in agricultural employment and 27.44 days in non-agricultural employment in 1956-57, Report of the Second Agricultural Labour Enquiry, Vol. I (All-India), *op.cit.*, p 68.

4 FMS West Godavary (Andhra Pradesh), *op.cit.*, p 82.

5 *Ibid.*, pp 91-97. The detailed break-down of employment of labour in the FMS, West Godavary (Andhra Pradesh) refers to adult male labour only. The contribution of women and children is ignored.

to gain employment as a result of cultivation of the new varieties on farms that traditionally are their sources of employment. Other things being equal, agricultural labourers who have plots of land that enable them to eke out a living by the cultivation of the new varieties, are less likely to offer themselves for employment on other farms if additional effort is required on their own farms.[1] Small farmers belong to this category. These are theoretical possibilities. They have to be set off against some tendencies observed by the National Commission of Labour. It found that as a result of resumption of land for direct cultivation by land owners owing to the increased profitability of cultivating the new varieties, cases of eviction of small farmers had increased.[2] Furthermore, fragmentation and the increase in the number of landholdings reduced the demand for hired labour because owners of small holdings had neither the need nor the capacity to employ outside labour. As Raj observed, "The tendency of bigger holders of land is neither to lease out land to small holders nor to hire labour on a large scale, but to adopt labour-saving devices as far as possible..."[3] All this indicates that, although an estimate of labour requirement is possible which indicates "potential" employment, it is impossible to judge the nature of its distribution among various agricultural classes. Also, any estimate of increased labour requirement will have to take into account factors making for mechanisation of farm operations.

1 The preference for work on own farms among agricultural labourers was noted by Visaria,P. 'The Farmer's Preference for Work on Family Farms,' im the Report of the Committee of Experts on Unemployment Estimates,' op.cit., Appendix VI, pp 185-194.

2 National Commission on Labour, op.cit., p 395.

3 Raj,K.N. 'Some Questions concerning Growth, Transformation and Planning in Agriculture in the Developing Countries,' Economic Development in South Asia, op.cit., p 125. Raj refers to this phenomenon in relation to the cultivation of all crops.

IV.3. Composition of Rural Households in West Godavary with regard to Family Labour and Hired Labour

Men, women and children formed equal proportions of the total population in West Godavary in 1959-60.[1] Nearly 60 per cent of the total number of farm households had an average of 5.5 members. The average numbers of members on farms cultivating rice was 5.38.[2] Farm households consisted of earners and dependents.[3] The average number of earners and dependents per holding and per acre are given in Table IV.7 below. About 80 per cent of farms in the paddy zone were composed of families with one or more earners.[4] No trend is discernible as regards the number of earners per holding as size of farm increases. But the number of earners per acre decreases steadily as the size of farm increases. The movement of dependents per acre also shows a similar trend. Column 7 shows the number of earners per acre engaged mainly in agricultural activities. Earners engaged mainly in agriculture and annual farm servants compose the total supply of labour on farms in the paddy zone. Total family labour per acre and per holding are given in Table IV.8.[5]

1 FMS, (Andhra Pradesh), op.cit., p 64. The proportions are 32.09, 33.42 and 34.50 for men, women and children respectively.

2 Ibid., p 70.

3 50 per cent of dependents are children and about 42 per cent are women who are not in the labour force because of social reasons, ibid., p 78.

4 Ibid., p 70.

5 Refer to previous section for the composition of family labour.

Table IV.7. Distribution of Family Labour according to Farm Sizes : West Godavary, 1959-60

Adult Males

Farm Size Group	Number of Earners per acre	Total Acreage	Total Number of Earners	Total Number of Farm Servants	Total Family Labour	Family Labour per acre
1	2	3	4	5	6	7
0.01 - 1.25	1.15	13.89	15.97	0.17	16.04	1.15
1.26 - 2.50	0.45	19.88	8.95	3.34	12.29	0.62
2.51 - 5.00	0.30	40.08	12.02	4.00	16.02	0.40
5.01 - 7.50	0.31	51.80	16.06	2.67	18.73	0.36
7.51 - 10.00	0.14	36.54	5.12	6.17	11.29	0.30
10.01 - 15.00	0.18	79.84	14.37	2.58	16.95	0.21
15.01 - 20.00	0.23	34.05	7.83	1.92	9.75	0.28
20.01 & Above	0.04	203.77	8.15	23.41	31.56	0.15
All Farms	0.18	479.85	86.37	44.26	130.63	0.27

Source: Tables 3.1, 3.34 & 3.44, FMS, West Godavary (Andhra Pradesh), op.cit., pp 13, 75 & 89

Table IV.8. Number of Earners and Dependents per acre and per holding, and number of Earners per acre engaged mainly in Agriculture according to Farm Size Groups: West Godavary, 1959-60

Farm Size Group (in acres)	Dependents per ten Earners	Number of Earners per Holding	Number of Dependents per Holding	Number of Earners per Acre	Number of Dependents per Acre	Number of Earners per acre engaged mainly in agriculture
1	2	3	4	5	6	7
0.01 - 1.25	10.78	1.80	1.94	2.45	2.66	1.15
1.26 - 2.50	18.96	1.82	3.45	0.96	1.96	0.45
2.51 - 5.00	30.00	1.25	3.75	0.37	1.13	0.30
5.01 - 7.50	12.00	2.50	3.00	0.39	0.46	0.31
7.51 - 10.00	23.33	1.50	3.50	0.16	0.39	0.14
10.01 - 15.00	17.10	2.83	4.84	0.21	0.37	0.18
15.01 - 20.00	23.75	4.00	9.50	0.23	0.46	0.23
20.01 & Above	39.84	1.29	5.14	0.04	0.18	0.04
Over All	18.92	1.86	3.52	0.27	0.50	0.18

Source: Tables 3.32 and 3.34, FMS, West Godavary (Andhra Pradesh), op.cit., pp 71 & 75.

Employment on farms takes the form of crop production, work on farms other than crop production, like tending cattle, working for other farmers in exchange or without remuneration, hiring out labour services and finally, attending to social and family duties. All except the last are regarded as productive employment. The employment pattern on farms is given in Table IV.9. It refers to adult male labour only.[1] The table shows that in general, the average number of working days spent on crop production on farms increased and those hired out decreased as farm size increased. This indicates that larger farms give greater scope for full utilisation of family labour. Tasks other than those involved in crop production inside farms are performed by annual servants and such labour is fully employed.[2] The employment pattern of both adult male members of the family and annual farm servants, collectively referred to as farm workers is given in Appendix Table IV.10. Owing to the nature of work done by the latter category of labour, total number of man-days spent in crop production is not altered significantly as a result of combining their contribution with with family members.[3]

1 The omission of the contribution of female labour means that the total number of man-days (in the sense of both male and female labour) is under-estimated.

2 FMS, West Godavary (Andhra Pradesh), op.cit., p 89.

3 Compare Column 2 in Tables IV.9 and IV.10.

Table IV.9. Average Annual Employment of an Adult Male Member of Farm Family according to Farm Size Groups

8-hours days

Farm Size (in acres)	Crop Production	Other than Crop Production	Exchange or Gratis	Hired Out	Service & Business	Social & Family Affairs	Total
1	2	3	4	5	6	7	8
0.01 - 1.25	27.61	48.32	4.31	69.89	43.68	7.84	201.65
1.26 - 2.50	42.19	84.30	3.34	52.69	82.09	6.93	271.54
2.51 - 5.00	55.86	68.60	7.87	68.42	19.00	6.88	226.63
55.01 - 7.50	76.82	60.99	5.81	51.45	12.56	5.72	213.35
7.51 - 10.00	68.85	37.48	0.30	-	49.85	7.35	163.83
10.01 - 15.00	93.80	30.41	7.37	44.71	15.55	9.84	201.68
15.01 - 20.00	89.80	27.73	7.45	10.33	0.28	10.05	145.64
20.00 & Above	111.58	26.75	-	-	5.31	29.17	172.81
All Farms	64.00	50.80	5.08	46.37	29.80	9.49	205.54

Source: Studies in the Economics of Farm Management, West Godavary (Andhra Pradesh), op.cit., p 81.

Table IV.10. Average Annual Employment of an Adult Male Member including Permanent Farm Servants according to Farm Size Groups

8-hour days

Farm Sizes (in acres)	Crop Production	Other than Crop Production	Exchange or Gratis	Hired Out	Service & Business	Social & Family Affairs	Total
1	2	3	4	5	6	7	8
0.01 - 1.25	27.38	51.17	4.27	69.30	43.31	7.77	203.20
1.26 - 2.50	33.92	132.17	2.65	31.92	65.49	5.85	281.93
2.51 - 5.00	43.01	139.75	6.01	52.32	14.53	5.25	260.87
5.01 - 7.50	69.68	92.32	5.07	44.02	10.66	5.83	227.58
7.51 - 10.00	72.52	165.26	4.70	-	25.92	25.30	293.70
10.01 - 15.00	79.29	55.56	6.34	38.50	13.39	11.92	205.00
15.01 - 20.00	76.27	75.20	6.01	8.33	0.23	8.10	174.14
20.00 & Above	111.56	179.89	7.76	0.63	1.38	49.28	250.50
All Farms	67.55	115.76	5.59	32.13	20.84	18.11	259.98

Source: Studies in the Economics of Farm Management, West Godavary (Andhra Pradesh), op.cit., p 94.

The pattern of employment as given in Tables IV.9 and IV.10 does not give the contribution of hired labour. These are given separately in the FMS, West Godavary for individual crop enterprises. The deployment of family labour and hired labour in the cultivation of irrigated paddy is reproduced in Table IV.11 below.

Table IV.11 Distribution of Family Labour and Hired Labour according to Farm Size

man-days per acre

Farm Size	Family Labour man-days	Family Labour per cent	Hired Labour man-days	Hired Labour per cent	Total man-days
0.01 - 1.25	22.13	50.69	21.53	49.31	43.66
1.26 - 2.50	14.95	33.44	29.76	66.56	44.71
2.51 - 5.00	14.23	38.76	22.48	61.24	36.71
5.01 - 7.50	15.70	48.92	16.39	51.08	32.09
7.51 - 10.00	2.43	6.81	33.24	93.19	35.67
10.01 - 15.00	11.63	35.71	20.94	64.29	32.57
15.01 - 20.00	10.75	39.44	16.50	60.56	27.25
Above 20.00	0.98	2.15	44.56	97.85	45.54
Over All	7.31	18.57	32.06	81.43	39.37

Source: Studies in the Economics of Farm Management, West Godavary (Andhra Pradesh), op.cit., p 217.

The above table shows, on cursory examination, an inverse relationship between family labour and farm size and a direct relationship between hired labour and farm size.[1] The movements in the two categories of labour are more or less evened-out as is evident from the size of total labour inputs on farms of different sizes.

The above description of the composition of labour on farms studied by the Farm Management Study and the distribution of total labour input among different operations on farms of different sizes provides the background for the employment pattern on farms cultivating traditional varieties of rice. Our estimates of labour requirements of traditional and HYV rice are based, however, on the data given in the Report for Kharif and the Report for Rabi. As these reports do not give full descriptions of labour utilisation in rice cultivation, we have had to take recourse to the Survey data. We turn now to the estimation of labour requirements for traditional and HYV rice.

1 The reason why small farms hire labour at all is because in a predominantly subsistence set-up, it is imperative for farmers to complete seasonal operations on time. Thus although small farms are allegedly family farms they have to hire labour. This has implications for large-scale cultivation of HYV. It is this, other things being equal, demand for labour by small farms and large farms are likely to be competitive. One possible violation of the cet.par. assumption that immediately comes to mind is mechanisation. This prospect, as we mentioned earlier is discussed at the end of this chapter.

IV.4. Estimates of Labour Requirements of Traditional and Higher-Yielding Varieties of Rice for West Godavary, 1968-69

The technical capacity of agriculture to absorb labour is given by the relationship between yield per acre and labour input per acre. It is on the strength of this relationship that increased labour requirements are anticipated. The easiest method of arriving at this relationship is to fit an agricultural production function. However, the complementary nature of inputs accompanying HYV, and indeed in production relationships in agriculture in general renders the estimation of production functions invalid.[1] What is more, it is precisely the complementarity between the labour input and other material inputs which is expected to increase the technical capacity of agriculture to absorb labour.[2] In the following analysis we will examine the functional relationship between crop yields and different kinds of labour by calculating the yield elasticity of traditional and HYV with respect to family labour, hired labour and total labour. Labour requirements are calculated by regressing the three types of labour on yield.

Despite the limitations of the technique, the production relationship established by us is by means of an unrestricted Cobb-Douglas production function. Data are in original values, not logarithms as there appeared to be little basis for choosing other than a linear model within the range of data available. All equations used are static ones. Although there are

1 Ishikawa,S. Economic Development in Asian Perspective, op.cit., p 217. His approach consists of making comparisons between observed labour input and observed crop output. For a critique of the use of Cobb-Douglas function in relation to Indian agriculture see Chand,M. 'On Using Cobb-Douglas Production Function in Agriculture with reference to India,' Indian Journal of Economics, XLVIII, 188-191, Oct. 1967, pp 193-207.

2 Based on inter-country relationships for rice, Ishikawa has demonstrated the complementarity between labour input and other material inputs, ibid., pp 216-249. He concludes that these relationships show that increases in output are rarely associated with increases in labour input alone.

reasons to believe that many production relationships in agriculture are recursive, the relationship between yield and total labour input in a season can be defined in static terms.[1] Two equations each were fitted for the data for our sample farms cultivating traditional and HYV. The first equation consists of two independent variable and the second equation has, in addition to those in the first equation two additional variables. The general functions used are the following:

Equation I: $$Y = a + b_i X_i + c_i S + u$$

Equation II: $$Y = a + b_i X_i + c_i F + d_i W + e_i S + v$$

where Y is yield per acre; b_i, c_i, d_i, and e_i are production coefficients and u and v are disturbance terms; S is farm size, F stands for expenditure on fertilisers, W for percentage area irrigated and X stands for labour input signifying family labour, hired labour and total labour in the two equations in turn. The results of the regressions are presented in Tables IV.12, IV.13 and IV.14. The independent variables as they appear in the tables are defined below:

Independent variables:

X_1 = family labour

X_2 = hired labour

X_3 = total labour (family + hired)

X_4 = farm size

X_5 = expenditure on fertilisers (Rs/acre)

X_6 = percentage area irrigated.

1 There is a recursive element when we consider yield-labour relationship over different operations in the same season. For instance, yield per acre at harvest time will depend upon the amount of labour applied during either the transplanting or even the ploughing period.

Table IV.12. Levels of Yield per Acre explained by Family Labour, Farm Size, Expenditure on Fertilizers and Percentage Area Irrigated, West Godavary, 1968-69

	Traditional Varieties		Higher-Yielding Varieties	
	Equation I	Equation II	Equation I	Equation II
Constant	24.63	-334.26	19.07	17.09
Family Labour (X_1)	2.54 (1.03)	1.65 (1.07)	0.05 (0.12)	0.06 (0.12)
Farm Size (X_4)	-0.28 (0.45)	-0.45 (0.44)	0.03 (0.06)	0.02 (0.07)
Expenditure on Fertilisers (X_5)	-	0.15 (0.08)	-	0.02 (0.01)
Percentage Area Irrigated (X_6)	-	3.55 (3.26)	-	-0.02 (0.47)
R^2	0.64	0.73	0.13	0.52
Number of Observations	20	20	20	20
Significant Coefficients	X_1 (5%)	X_5 (5%)	None	X_5 (5%)

Source: Based on Appendix Tables VII, IX and XI - XII

Note: Figures in brackets under regression coefficients are standard errors; those in the last row are significance levels.

Table IV.13. Levels of Yield per Acre explained by Hired Labour, Farm Size, Expenditure on Fertilisers and Percentage Area Irrigated, West Godavary, 1968-69

	Traditional Varieties		Higher-Yielding Varieties	
	Equation I	Equation II	Equation I	Equation II
Constant	44.18	-349.33	13.73	-69.56
Hired Labour (X_2)	-0.03 (0.38)	-0.22 (0.41)	0.09 (0.03)	0.11 (0.03)
Farm Size (X_4)	-0.89 (0.44)	-0.82 (0.38)	0.002 (0.045)	-0.01 (0.04)
Expenditure on Fertilisers (X_5)	-	0.21 (0.08)	-	0.02 (0.01)
Percentage Area Irrigated (X_6)	-	3.88 (3.83)	-	0.78 (0.41)
R^2	0.44	0.68	0.59	0.75
Number of Observations	20	20	20	20
Significant Coefficients	X_4 (5%)	X_4, X_5 (5%), (1%)	X_2 (1%)	X_2, X_5 (1%), (5%)

Source: Same as Table lV.12.

Note: See note for Table lV.12.

Table IV.14. Levels of Yield per Acre explained by Total Labour (Family + Hired), Farm Size, Expenditure on Fertilisers and Percentage Area Irrigated, West Godavary, 1968-69

	Traditional Varieties		Higher-Yielding Varieties	
	Equation I	Equation II	Equation I	Equation II
Constant	30.51	-454.67	12.33	-53.10
Total Labour (X_3)	0.21 (0.36)	-0.01 (0.41)	0.10 (0.03)	0.11 (0.03)
Farm Size (X_4)	-0.86 (0.44)	-0.84 (0.39)	0.03 (0.04)	0.02 (0.04)
Expenditure on Fertilisers (X_5)	-	0.20 (0.08)	-	0.02 (0.01)
Percentage Area Irrigated (X_6)	-	4.84 (3.70)	-	0.62 (0.38)
R^2	0.46	0.68	0.63	0.76
Number of Observations	20	20	20	20
Significant Coefficients	X_4 (5%)	X_4, X_5 (5%), (5%)	X_3 (1%)	X_3, X_5 (1%), (5%)

Source: Same as Table IV.12.

Note: See note for Table IV.12.

Analysing the results for traditional varieties, taking Equation I we find that family labour is a significant factor explaining yields. Yield and farm size show a negative but weak relationship. A similar relationship is observed between yield and hired labour in the equation containing hired labour as one of the independent variables. Here, farm size is a significant explanatory variable. In the case of total labour, there is a strong negative relationship between farm size and yield. With the addition of the two extra variables in Euqation II, while these relationships are preserved, fertilisers emerge as the most significant variable explaining yield increases. The inclusion of extra independent variables improved the R^2's all round.

Turning now to the equations for HYV, the role of family labour appears unimportant in explaining yields, fertilisers being more important than family labour, in Equation I. By contrast, in the Equation II for HYV, both hired labour and fertilisers are significant variables, explaining yield. In the case of total labour, while it is a significant variable in Equation I, its role is taken by fertilisers in Equation II. As in the case of traditional varieties, the additional variables in Equation II improved the R^2.

Summarising the above, we notice that the relationship between yield and family labour is strong in the case of traditional varieties. The relationship between yield and hired labour is negative but weak in the case of traditional varieties. It is positive and strong in the case of HYV. Fertilisers appear to be consistently important in all the relationships studied. The contribution of the irrigation input is statistically insignificant all round. Our natural expectation is that increased fertiliser application as in the case of HYV goes with increased irrigation intensity. It is probable that the smallness of our sample is responsible for the relative unimportance of the irrigation input in our equations.

As the data used to fit regression equations presented in the foregoing tables is in the non-logarithmic form, the input coefficients cannot be interpreted as labour elasticities. These have been calculated by using the alternative formula for deriving elasticities.[1] Table IV.15 presents yield elasticities with respect to the three different kinds of labour.

Table IV.15 Yield Elasticity with respect to Family Labour, Hired Labour and Total Labour

Varieties and Equations	Elasticity with respect to:		
	Family Labour	Hired Labour	Total Labour
Traditional Varieties			
Equation I	0.05	0.05	0.40
Equation II	0.03	0.39	0.02
Higher-Yielding Varieties			
Equation I	0.01	0.29	0.35
Equation II	0.01	0.36	0.38

Source: Same as Table IV.12.

The figures show some interesting results. In the case of traditional varieties, yield elasticity with respect to total labour (family plus hired labour) is high in the absence of fertiliser and irrigation inputs. The addition of the

1 Elasticity $n = b_i \frac{\bar{x}_i}{\bar{y}_i}$, where $\bar{x}_i$ and $\bar{y}_i$ refer to the statistical means of the inputs of labour and yield respectively.

latter inputs in Equation II for hired labour increased the yield elasticity with respect to this input. This could be interpreted to mean that there is a strong correlation between labour and material inputs even in the cultivation of traditional varieties. In the case of HYV, yield elasticity with respect to total labour is higher than with respect to both family and hired labour taken separately. Yield elasticity with respect to hired labour is higher with the addition of fertiliser and irrigation in Equation II.

Interesting as these results are, we cannot draw definite conclusions from so small a sample. But these results lend credibility in a mild way to the hypothesis that there is a strong positive relationship between labour, especially hired labour, and complementary inputs and it is this that forms the basis of the principal hypothesis of this chapter, namely, the cultivation of HYV will increase the employment potential on farms.[1] The likely magnitude of such increases on our sample farms is presented in Tables IV.16 and IV.17. They show, respectively, the actual and estimated labour requirements of traditional and HYV.

1 Farm Management Surveys conducted by the Agro-economic Research Centre, Madras showed that IR-8 required 40 per cent more labour than ADT-27, total labour requirements per acre for the two varieties being 75 man-days and 53 man-days respectively. The increased requirement was ascribed to increased number of ploughings, line-planting, intensive weeding, etc., Muthiah, C.H. 'The Agricultural Labour Problem in Tanjore and the New Agricultural Strategy,' IJAE, XXV, 3, July-Sept. 1970, pp 15-23. It seems that intensive cultivation has a tangential effect on family planning! Flavier, while recounting his experiences with rural reconstruction in the Philippines, quotes a farmer as saying "IR-8 is good for family planning. I have to care for it all day long. I am so tired when I go home that I fall asleep right away." Flavier, J.M. Doctor to the Barrios, Experiences with the Philippine Rural Reconstruction Movement, New Day Publishers, Quezon City, 1970, p 100.

Table IV.16. Actual and Estimated Requirements of Family Labour, Hired Labour and Total Labour for Traditional Varieties of Rice in Man-Days per Acre, West Godavary, Kharif and Rabi, 1968-69

	Family Labour		Hired Labour		Total Labour		
	Actual	Estimated	Actual	Estimated	Actual	Estimated	Difference between actual & estimated as a percentage of actual
1	2	3	4	5	6	7	8
<u>Kharif</u>							
Below 5.00	7	5	58	47	65	52	- 20
5.01-10.00	2	3	51	48	53	51	- 4
10.01-15.00	0	1	55	49	55	50	- 9
15.01-20.00	1	1	66	48	67	49	- 27
20.00 & above	0	0	54	49	54	46	- 15
<u>Rabi</u>							
Below 5.00	19	8	52	54	71	62	- 13
5.01-10.00	7	10	72	51	79	61	- 23
10.01-15.00	0	2	76	.77	76	80	+ 5
15.01-20.00	6	3	77	72	83	75	- 10
20.00 & above	0	4	73	57	73	62	- 15

Source: Columns 2, 4 & 6 based on <u>Report for Kharif</u>, <u>op.cit</u>., Appendix Table 12 and <u>Report for Rabi</u>, <u>op.cit</u>., Appendix Table 12
Columns 3, 5 & 7 computed
Column 8, computed from Columns 6 & 7.

Table IV.17. Actual and Estimated Requirements of Family Labour, Hired Labour and Total Labour for Higher-Yielding Varieties of Rice in Man-Days per Acre, West Godavary, Kharif and Rabi, 1968-69

	Family Labour		Hired Labour		Total Labour		
	Actual	Estimated	Actual	Estimated	Actual	Estimated	Difference between actual & estimated as a percentage of actual
1	2	3	4	5	6	7	8
Kharif							
Below 5.00	14	9	66	70	80	79	- 1
5.01-10.00	3	7	71	57	74	63	- 15
10.01-15.00	1	6	75	67	76	73	- 4
15.01-20.00	1	4	79	72	80	75	- 6
20.00 & above	0	-4	63	61	63	57	- 10
Rabi							
Below 5.00	24	9	65	63	89	71	- 20
5.01-10.00	10	7	74	60	84	68	- 19
10.01-15.00	0	-1	86	88	86	87	+ 1
15.01-20.00	0	1	107	103	107	103	- 4
20.00 & above	0	4	82	71	82	75	- 8

Source: Columns 2, 4 & 6 based on Report for Kharif, op.cit., Appendix Table 12 and Report for Rabi, op.cit., Appendix Table 11.
Columns 3, 5 & 7 computed.
Column 8 computed from Columns 6 & 7

From the foregoing tables we gather that estimated values of total labour requirements for both varieties are lower than actual requirements for all farm sizes in both seasons except those in size-class 15-20 acres in the Rabi season. The percentage variation in estimated values for both varieties in both seasons are quite dramatic. This is shown in Column 8 in both tables. As with actual requirements of total labour, estimated labour requirements are higher for HYV than those for traditional varieties for all farm sizes. The difference between the estimated labour requirements for HYV and the estimated requirements for traditional varieties as a percentage of estimated values for traditional varieties are the following:

Farm Size (acres)	Below 5.00	5.01-10.00	10.01-15.00	15.01-20.00	20.01 & Above
Season					
Kharif	+34	+33	+32	+35	+19
Rabi	+13	+10	+ 8	+27	+17

The most that we can conclude from our calculations is that the cultivation of HYV will lead to higher per acre demand for labour than the cultivation of traditional varieties. On account of the not entirely plausible assumption we make in our analysis, namely, that all farms possess the material resources to cultivate the new seeds, these figures cannot be regarded as giving more than a very general order of magnitude of increased labour requirements per acre. Assuming away the pitfalls in using aggregated data to arrive at results at the micro-level, the merit we claim for our estimates is that they have been derived from a detailed analysis of the structure of labour and material inputs on farms of different sizes and as such can be regarded as being immune from the criticisms usually levelled at one-equation-one-independent-variable models which search for the highest correlation between two variables.

The discussion so far has been based on the assumption that the the cultivation of higher-yielding varieties of rice is not accompanied by mechanisation of agricultural operations. The central theme in the discussion of the employment effects of HYV is mechanisation. The advent of the tractor has been generally hailed as enabling greater employment via intensification of production and the practice of double-cropping. This is, of course, a theoretical possibility. As the pressures that force farms to mechanise are varied and the effects of mechanisation derive from its interaction with the institutional structure of agriculture, it is hazardous to attempt to separate the causes and effects of mechanisation. Our reflections on the possible effects of mechanisation of rice cultivation on our sample farms are more in the nature of speculation tempered by the experience of Japan and Punjab.

Mechanisation of wheat cultivation in Punjab has progressed at a rapid rate.[1] This phenomenon has been explained in many ways, but as yet we are not in a position to say on the basis of empirical evidence whether mechanisation is employment-creating or employment-destroying. Rao ascribes the rapid growth in mechanisation to the higher relative cost of biological sources of energy compared to mechanical sources.[2] Commenting on Rao's analysis

1 Between 1966-67 and 1969-70, the use of tractor power in Punjab increased by 44 per cent. The increase in tractor hours per acre of cropped area is as follows:

1966-67	11.94
1967-68	9.58
1968-69	12.72
1969-70	17.24

Johl, S.S. 'Mechanisation, Labour Use and Productivity in Agriculture,' ASI, XVIII, 1, April 1973, pp 3-16.

2 Rao, C.H.H. 'Farm Mechanisation in Labour Abundant Economy,' EPW, VII, 5, 6 & 7, (Annual Number), Feb. 1972, pp 393-400. Extension of irrigation could also be another reason from the substitution of bullock power by tractors. Parthasarathy refers to this kind of substitution in Andhra Pradesh, Agricultural Development and Small Farmers - a Study of Andhra Pradesh, op.cit., pp 35-37.

Khalon and Grewal argue that the reasons for mechanisation are the need to carry our seasonal operations in time and to circumvent labour shortages during peak periods.[1] According to them the profitability of cultivating HYV wheat and increased cropping intensity has led to the demand for additional sources of energy. They challenge Rao's argument by asking why, if bullocks are costly to maintain, they are still kept on farms that possess tractors. The answer is - "for guarding against sudden tractor break-down," and this, as Raj points out, makes the economic case for the substitution of animal power by tractors even weaker.[2] Raj goes on to show how, in order to be able to determine the contribution of mechanisation to growth in output and employment, we need adequate information on the relative proportions of different levels of input and output in relation to all activities concerned with the growing of a crop.[3]

Assessment of the possible impact of mechanisation on our sample farms is not possible for want of data. What information is available refers to the Kharif season only. Even then, only a rough idea of the level of technology as measured by the capital intensity can be got from the Report for Kharif. The average per acre capital investment is higher in the cultivation of HYV than in the cultivation of traditional varieties by about

1 Khalon,A.S. & Grewal,S.S. 'Farm Mechanisation in a Labour Abundant Economy - A Comment,' EPW, VII, 20, May, 1972, pp 991-992.

2 Raj,K.N. 'Mechanisation of Agriculture in India and Sri Lanka (Ceylon),' in Mechanisation and Employment in Agriculture, op.cit., p 125.

3 "Scientific and technological advances offer a wide variety of crop rotations and combinations and for each crop, several alternative techniques of production involving different kinds of input - depending on the climatic, soil and hydrological and other such characteristics of each region. To answer this question one therefore has to have technical data about all the alternatives, as well as the prices appropriate in each case to the valuation of the inputs and the outputs concerned." Ibid., p 111.

50 per cent. In the cultivation of all varieties in both districts, there is a positive correlation between labour input per acre and investment per acre.[1] The capital-labour ratio is lower in the case of HYV compared to traditional varieties. From the above tendencies it is possible to infer that while the absolute levels of capital and labour are increasing, there is some substitution between labour and capital inputs.[2]

The effects or even the causes of mechanisation cannot be isolated from the size of farms. Owing to their superior income position and the greater access to credit, large farmers are more likely to introduce machinery on farms and if they do so, the employment prospects of agricultural labourers on such farms are likely to be threatened. The consequences of this are likely to be particularly severe in Andhra Pradesh where agricultural labourers constitute such a high proportion of the total work force in agriculture. Agricultural labourers constitute 41 per cent of the total work force in agriculture.[3] Of course, this possibility can be avoided if there is an increase in the intensity of cropping. We believe that the increased demand for labour per acre in this way are still academic because the preconditions that need to be fulfilled for the practice of multiple cropping amount to a

1 Report for Kharif, op.cit., pp 91-94.

2 To explore fully the nature of capital-labour substitution one would have to develop a projection model similar to that used by Singh and Day in the study of capital labour substitution in Punjab. Based on the observed pattern of capital-labour utilisation and substitution between the two, the authors believe that Punjab agriculture will be fully mechanised by 1980, Singh,I. and Day,R.H. Capital-Labour Utilisation and Substitution in Punjab Agriculture, Social Systems Research Institute, University of Wisconsin, March 1972, pp 21-23.

3 Government of India, Indian Labour Yearbook, 1965, p 344. Agricultural labourers constitute nearly 29 per cent of the total labour force (agriculture and industry) in Andhra Pradesh, ibid. Total farm labour force in agriculture in Andhra Pradesh constitutes 17 per cent of the total farm labour force in India, Krishna,J. 'Labour Market in Rural Areas,' IJAE, XXV, 3, July-Sept. 1970, pp 1-7.

whole agricultural programme![1] Furthermore, mechanisation does not offer the same economic advantages in the cultivation of rice that it does in the cultivation of upland crops like sugar-cane. Economies of scale cannot be expected when farm operating units are small. One of the reasons for the rapid increase in mechanisation in Punjab is that farms that possess tractors are on average, nearly 60 acres in size.[2] As we noted in Section IV.1 the very nature of rice cultivation precludes the possibility of mechanisation given the existing types of machinery available. From a comparative study of India and the Philippines, Barker noted that taking all cultural operations, mechanisation does not seem to offer substantial economies of scale in tropical rice cultivation in contrast to upland crops like rice.[3]

Our reasons for discounting the possibility of mechanisation of rice cultivation on a large scale and therefore the displacement of labour are based on the above-mentioned arguments. The present international oil crisis and India's continuing foreign exchange problems also lend support to our argument.[4]

1 Swaminathan,M.S. 'Concept of Crop Planning,' IF, XX, 3, June 1970, p 41. For the staggering list of preconditions for the practice of multiple-cropping see Murthy, T.R. 'Multiple Cropping,' in Indian National Science Academy, Proceedings of the Symposium on Science and India's Food Problem, New Delhi, 1971, pp 285-289.

2 Singh,B. 'Economics of Tractor-Cultivation: a Case-Study,' IJAE, XXlll, 1, Jan.-Mar. 1968, pp 83-88. Compare the average farm size in West Godavary, 7 acres.

3 Barker,R. 'The Evolutionary Nature of the New Rice Technology,' op.cit., p 124.

4 Of the total power requirement for carrying out timely operations in India, less than 50 per cent is now available, Roy,S.E. 'Increasing Agricultural Production through the use of Improved Machinery,' in Science and India's Food Problem, op.cit., p 283. Taking developing countries as a whole it is estimated that less than two-fifths of total horse-power requirement is supplied by human beings; therefore increased capital investment is not inconsistent with higher labour requirement per acre in the cultivation of crops, Schertz,L.P. 'The Role of Farm Mechanisation in the Developing Countries,' Foreign Agriculture, Vl, 48, Nov. 25 1968, pp 2-4.

Conclusion

The principal conclusion of this chapter is that the cultivation of HYV leads to increased labour requirement per acre. Estimates derived from sets of regression equations showed that both actual and estimated levels of labour input are higher in the case of HYV than for traditional varieties. On the basis of detailed analyses of the functional relationship between yield and different forms of labour we are able to state that the increased labour requirements in the cultivation of HYV are due both to the intensive nature of cultivation involved and due to the complementarity between labour and other material inputs. In fact, the latter relationship formed the basis of the principal hypothesis we set out to test in this chapter. As our estimates are based on a detailed analysis of the actual utilisation of labour and other inputs, they are more useful in depicting labour absorption at the micro-level than those based on projection models. In claiming that cultivation of HYV will increase employment on our sample farms we discount the possibility of large-scale mechanisation.

CHAPTER FIVE

CREDIT

The cultivation of HYV entails the use of inputs purchased off the farm. Most of these inputs represent capital investment and in the short period, that is, a crop season, they take the form of working capital requirements.[1] There are three principal forms of financing the purchase of these inputs, savings, sale of assets and borrowing. The actual method adopted will depend upon the type of farm - whether large or small. Large farms are more likely to finance the purchase of new inputs from their own resources while small farms, characterised by low incomes are more likely to finance the purchase of these inputs by borrowing.[2]

In theoretical studies of the profitability of non-conventional[3] inputs, especially chemical fertilisers, the elasticity of credit supply is assumed. This assumption is of the same family as those in macro-economic models of technical change where factor-product markets are treated as disembodied abstractions through which resources are transferred between farm

1 Shukla,T. 'Capital Formation in Indian Agriculture,' IJAE, XXV, 1, Jan.-Mar. 1970, p 20; Working capital requirements based on fertiliser-yield relationships for All-India have been calculated by Ishikawa, Economic Development in Asian Perspective, op.cit., pp 166-173.

2 Even if incomes are not low credit would still be needed if the period required to accumulate savings is long. An alternative to credit is renting. Machinery and livestock can be rented, but farm inputs like fertilisers and seeds are not adapted to rental systems.

3 Non-conventional input refers to any factor that shifts a conventionally specified production function upwards. Shultz refers to such factors as "neglected inputs," Schultz,T. 'Reflections on Agricultural Production, Output and Supply,' Journal of Farm Economics, XXXVIII, Aug. 1956, pp 748-762.

and non-farm sectors.[1] There is, in addition, a tendency to underestimate the resource flows from the industrial to the agricultural sector. Ishikawa was the first to point out how the assumption of elasticity of supply of credit is not tenable in practice in connection with his thesis that contrary to the classical pattern assumed in development literature, the experience of some Asian countries suggests that there has been a net outflow of capital from the industrial sector to the agricultural sector.[2] Once we assume that the supply of credit is not elastic and that at the micro-level all farms do not have equal access to credit to finance expenditure on new inputs then any consideration of the profitability of their use becomes academic. The growth in productivity on farms that are not self-financing will depend upon the availability of credit, and this means that the sources of credit have to be specified explicitly.[3]

The analysis of credit in relation to HYV is essentially that of the institutional system of credit. Ordinarily, the agricultural credit system is only a part of the general credit system in the economy and the success of the former in stimulating savings and maintaining a balance between different forms of capital depends upon the ability of the latter to do so. In India, the agricultural credit system, dominated by cooperative societies has an

1 The reference here is the model developed for example, Lewis,W.A. The Theory of Economic Growth, George, Allen and Unwin, London 1955; Ranis,G. and Fei,J.C.H. Development of the Labour Surplus Economy, Homewood, Illinois, 1964; Jorgenson,D.W. 'The Development of a Dual Economy,' Economic Journal, LXXX, 282, June 1961, pp 309-334.

2 Ishikawa,S. Economic Development in Asian Perspective, op.cit., pp 290-348.

3 Unlike farms that use own funds for the purchase of new inputs, in an externally financed farm the quantities of inputs cannot be pre-determined. They are determined during the growing period of crops, in any particular season, by the availability of credit. Thus the organisation of crop production on such farms will depend upon the characteristics of the credit supply function. Farm production plans drawn up by extension agencies will be of no avail if credit facilities to support the purchase of recommended inputs do not exist.

additional function in the context of HYVP. Cooperatives are the principal agencies for the distribution of nitrogenous fertilisers and constitute the machinery for the propagation of the new technology. The success of the new technology depends upon the degree of efficiency and timeliness with which fertilisers and other inputs are made available to farmers.

The organisation of cooperative credit as it exists in India is heavily biased in favour of large farms. This is because the lending policy of cooperative with regard to short-term, medium-term and long-term credit is based on the security of assets. Small farms possess low levels of assets and are therefore debarred from obtaining credit. The disqualification they suffer from on account of the small size of their holdings is compounded by the tenurial conditions attaching to the land they cultivate. This leads such farmers to use levels of inputs that are below recommended doses and this we feel represents unexploited potential for increasing rice production. The objective of this chapter is to show that small farmers will be able to make an impact on rice production if there is a greater detachment of the supply of credit from the asset structure of farms. Section V.1 deals with factors determining the demand for short-term credit. Section V.2 present estimates of working capital requirements on our sample farm. Sections V.3 and V.4 discuss the principal sources of supply of credit. Section V.5 gives a brief description of the Crop Loan Systems and this is followed by a brief summary of our main conclusions.

V.1. Demand for Credit

We are primarily concerned here with the estimation of short-term production credit requirement on our sample farmers. The relevant issues are the determination of levels of cash expenditure on new inputs and the assessment of what proportion of the increased expenditure has to be financed by institutional credit. The importance of credit on small farms arises both from the low level of savings and risk and uncertainty attaching to the cultivation of the new varieties. The low level of savings and the inability to bear risks can be traced to the low income-high-consumption base of small farms.

In the shortperiod the level of savings is given by the difference between current disposable income and current consumption.[1] If, with a given level of income, minimum consumption needs are satisfied and there are no pre-existing liabilities, then increases in income will lead to positive savings. If these assumptions are not satisfied, then negative savings will result. Income deficits give a measure of negative savings. As consumption expenditure is not recorded in the data for our sample farms, neither average nor marginal propensities to save could be calculated. For evidence on the nature of rural savings one has to rely on the results of All-India Surveys. According to the All-India Rural Credit Survey, gross savings (total investment minus dis-investment) was negative among small farmers.[2] Again, the

1 We are constrained to use this definition as our analysis is based on cross-section analysis. Alternatively, savings could have been defined as the difference between the value of assets and liabilities. Current expenditure refers to both current farm expenses and domestic expenditure.

2 Reserve Bank of India, <u>All-India Rural Credit Survey</u>, Vol. I - III, Bombay 1954, Vol. I, <u>The Survey Report</u>, p 799.

All-India Rural Household Survey reported that the savings of 60 per cent of households arranged according to percentile groups was negative.[1] From the All-India Rural Debt and Investment Survey we find that not only was current income deficits the chief cause of borrowing but repayment of outstanding loans was itself made from fresh borrowings, and this practice was more widespread in Andhra Pradesh than in the other states.[2] In West Godavary, 75 per cent of households was in debt in 1959-60.[3]

Indebtedness among rural households can be analysed either by looking at loans outstanding or current borrowings also referred to as average new debt.[4] No definite conclusions can be drawn from the mere size of average new debt. As the ARCS observed, high debt can be the sign of a very considerable degree of monetisation and the practice of borrowing working capital during the year.[5] Seasonality in the production of a crop such as rice is an important determinant, for, borrowing for productive purposes is cumulative during the growing period.[6] If, in addition, the district offers scope for

1 National Council of Applied Economic Research, <u>All-India Rural Household Survey</u>, <u>Vol. II</u>, New Delhi, 1962, p 132.

2 'All-India Rural Debt and Investment Survey,' <u>RBIB</u>, XX, 9, Sept. 1965, pp 1296-1393, especially p 1313. In 1954-55, 53 per cent of repayment was by means of fresh borrowings, 40 per cent by savings and 7 per cent by sale of assets, Government of India, Cabinet Secretariat, National Sample Survey, <u>Tables with Notes on Rural Indebtedness</u>, 8th Round, No. 68, July 1954 to April 1955, New Delhi, 1962, p 10.

3 <u>FMS (West Godavary) 1959-60</u>, <u>op.cit.</u>, p 56.

4 The National Sample Survey noted that the distribution of both current borrowings and amount of outstanding loans among rural households were similar, Tables with Notes on Rural Indebtedness, op.cit., p 8.

5 <u>ARCS</u>, <u>Vol. I</u>, <u>The Survey Report</u>, <u>op.cit.</u>, pp 80-82.

6 A peculiarity of agriculture, especially, monoculture like rice production is that accrual of income is concentrated during periods like harvest time while the use of inputs like water for irrigation, fertilisers is spread throughout the growing period.

capital investment, farmers will borrow amounts for development purposes. It is interesting to observe in this connection that Andhra Pradesh ranks among those states where the proportion of productive assets such as land and equipment used in farm and non-farm business to total tangible wealth is greater than the national average.[1] In areas where farming is not highly developed and the degree of monetisation is low and where the level of cash receipts, current expenses and investment are all low, the level of outstanding debt will be high if a succession of bad harvests led to borrowing for consumption and production in the past.[2] Thus, when incomes are low, annual fluctuations in crop output lead to increasing debt and declining spendable income. The spiralling of debt increases the importance of external borrowing.

Turning to the composition of average new debt, although it is not possible to separate production and consumption elements in the Farm Management data, some idea can be had from the results of the analysis of borrowing by purpose from other surveys. The picture that emerges from the All-India Rural Debt and Investment Survey is the following:

Amount borrowed for different purposes as percentage of total amount borrowed from all sources, Andhra Pradesh, 1961-62.

Capital Expenditure on Farm Business	25.1
Current Expenditure on Farm Business	11.8
Capital & Current Expenditure on non-farm business	3.0
Household Expenditure	39.7
Other Purposes	20.4

Source: Reserve Bank of India, Report of All-India Rural Credit Review Committee, Bombay, 1969, p 51.

1 Pannikar,P.G.K. 'Capital Formation in Indian Agriculture,' IJAE, XXIV, 4, Oct.-Dec. 1969, pp 31-44.

2 High levels of average new debt could also arise because long and medium-term loans have not been liquidated.

We can see from these figures that household expenditure constituted the highest percentage of total amount borrowed. The importance of consumption expenditure can be gathered from this.[1] The importance of consumption can also be gathered from the distribution of cash loans among different purposes. In Andhra Pradesh in 1962, household expenditure formed 55 per cent of cash loans outstanding and 38 per cent of average new debt.[2] Ideally we need to know the percentage of loans taken in the form of cash to total loans. We have no data for recent years. In 1954-55 of the total amount of loans taken during the agricultural year, 71 per cent was taken in the form of cash and 29 per cent in kind.[3] While these figures enable us to separate, roughly, consumption loans from production loans, their relative importance can only be assessed from an analysis of borrowing according to the size distribution of farms. According to the ARCS, the smallest cultivator borrowed proportionately more for domestic expenditure than for other purposes, the pattern being reversed for large cultivators.[4] More recent data on borrowing for different purposes

1 No attempt has been made by us to derive the functional relationship between consumption expenditure and average new debt or loans outstanding for our state because of lack of sufficient data. In his study of rural money markets in India, Ghatak found a strong positive relationship between consumption expenditure and total loans outstanding only in the 1950's. In the 1960's, however, capital expenditure was a more significant variable explaining both loans outstanding and average new debt, Ghatak, S. Rural Money Markets in India, (Unpublished PhD Thesis), London, 1972, pp 77-78.

2 AIRDIS, op.cit., pp 1330 and 1365.

3 Tables with Notes on Rural Indebtedness, op.cit., p 8.

4 Reserve Bank of India, Report of the All-India Rural Credit Review Committee, Bombay, 1969, p 45. The data refer to cooperative credit obtained by farmers for the cultivation of traditional varieties of rice and applies to the district of West Godavary when it was part of the erstwhile state of Madras. The All-India Rural Credit Survey was undertaken before the reorganisation of states on linguistic lines in 1956. The Survey classified farms into "large," "medium" and small" and they refer to the top 30 per cent, the middle 40 per cent and the bottom 30 per cent of cultivators arranged according to farm sizes. "Big" refers to the 10 per cent of the "large" category, ARCS, Vol. III, The Technical Report, op.cit., p 3-5.

according to farm size are hard to come by especially at the state and district levels. Taking size of assets[1] as a proxy for farm size, the AIRDIS data for All-India shows that farms with lower levels of assets borrowed proportionately more for meeting household expenditure compared to capital expenditure than farms with higher levels of assets.[2]

The distinction between production and consumption credit cannot be made in the case of our sample farms because the data refer to production credit alone.[3] On small farms the distinction between production and consumption credit is very difficult to make. It could be argued that the distinction is, in fact, arbitrary and misleading being based as it is on the nature of the article or articles purchased by means of the loan. Suppose loans are taken ostensibly for the purchase of fertilisers. Assuming that fertilisers would have been purchased anyway by the farmer, the loan will, in fact, release spending power for consumption. Secondly, as farm households and farm enterprises are coterminus on small farms, i.e. members of the family constitute labour supply on the farm, their maintenance is part of production expenses rather than consumption expenses.[4] A more useful distinction is one drawn between types of credit which are used in a manner that provides no more than the maintenance of a static short-run consumption pattern and that which allows expansion of the use of inputs and therefore production. Here we see that the opportunity for production credit arises in the context of traditional agriculture experiencing technological change. Unless small farmers are enabled to break away from the static income base by a fortuitous sequence of good harvests from the cultivation of both traditional and new varieties, the credit system has to make

1 For definition of assets, see below p 243.

2 RAIRCRC, op.cit., p 50. We have attempted to relate farm size and the level of assets, refer Section V.3 below.

3 Rough approximations can be made by deducting production expenses from total amounts borrowed from cooperatives or the amounts taken from private money-lenders could be regarded as forming part of consumption loans.

4 On the grounds that a significant proportion of borrowing by large farmers for "current agricultural expenses" is used for the payment of wages, see Rao, C.H.H. 'Farm Size and Credit Policy,' EPW, V, 52, Dec. 1970, p A161.

good deficits in income.

The new strategy as it related to credit has consistently underestimated the importance of consumption credit. The AIRCRC recognised the need to include some element of maintenance expenditure while estimating production credit requirements and also recognised the danger that too great an orientation of cooperative credit to production needs might itself result in the larger flow of credit to large cultivators. It did not go on, however, to devise a method by which the latter could be compelled to rely on their own resources in financing increased production costs.[1] The insistence on the disbursement of credit in kind is a reflection of the underestimation of consumption needs of small farmers and in fact the neglect of the special needs of this category of farmers.[2] The rationale of the recommendation that credit should be given in kind as far as possible is that cash loans tend to be put to unproductive uses. The recommendation assumes that adequate arrangements exist for providing inputs to farmers in the right place and at the right time. But this is not so as our analysis of the provision for the distribution of fertilisers has proved.[3]

Income deficits on small farms imply not only low rates of capital formation on such farms but also low risk-bearing ability. Small farmers are disinclined to innovate and invest in new inputs, because their reserve borrowing capacity is very low. This is specially so in the case of new

1 RAIRCRC, op.cit., pp 68-69 and p 79.

2 The proportions of the cash and kind element is credit granted for the cultivation of HYV are respectively, 44 per cent and 55 per cent, RAIRCRC, ibid., p 88.

3 Refer Chapter on Fertilisers; see also Anon, 'Farm Credit in Kind,' EPW, IV, 37, Sept. 13, 1969, p 1466. The shortcomings of the Crop Loan System can also be traced to the neglect of consumption loans and this is explained in Section V.5.

varieties whose cultivation is fraught with increased production risks. As Heady has observed:

> " The 'degree of uncertainty' even in the innovation of a new crop which does not increase capital outlay stands to be great for a person whose meagre income and food supply makes subsistence precarious in any year ... the low income farmer or cultivator must certainly hesitate in substituting a new variety and method for one which has 'proven the test of time' in keeping him fed."[1]

From a study of the pattern of capital formation in Andhra Pradesh, Rao found that although the rate of capital formation in the state was higher than the national average, the rate of growth of agricultural productivity in recent times is not commensurate with it.[2] He ascribes this to the predominance of small farms in the state.

The circular relationship between capital formation and productivity is apparent when we consider that capital formation is a function of productivity which in turn is a function of investment. Income deficits constitute capital constraints which prevent small farmers from investing in new outputs. The need to break this circular relationship is all the more pressing when we view recent evidence on capital formation in India. Return on investment of the magnitude of 15-25 per cent of agricultural income was the chief source of capital formation, credit played a minor role.[3]

1 Heady, E.O. Agricultural Policy under Economic Development, Iowa State University Press, Iowa, 1962, p 572; compare "There is no reasonable doubt that a static or retrogressive condition of agriculture often has as a major cause a simple lack of ready money in the hands of the farmer," Binns, B.O. Agricultural Credit for Small Farmers, Food and Agricultural Organisation, Development Paper No. 16, p Forward.

2 Rao, V.R.B.S. 'Changing Pattern of Material Capital Formation in Andhra Pradesh Agriculture,' IJAE, XXIV, 4, Oct.-Dec. 1969, pp 132-133.

3 Shukla, T. Rapporteur's Report on the Conference on Capital Formation in India, XXV, 1, Jan.-Mar. 1970, p 20. It is interesting to note that much the same phenomenon was observed in the USA Capital formation in Agriculture was financed internally from gross farm incomes rather than from external capital or credit, Toslbe, A.S. Capital in Agriculture - its Formation and Financing since 1980, Princeton University Press, Princeton, 1957, p 19.

The disincentives faced by small farmers in innovating is compounded by the insecurity arising from tenurial conditions. When the use of a productive asset like land is the preclusive right of an individual farmer, it motivates him not only to achieve a surplus but also to re-invest it in the enterprise. The real importance of security of tenure in the matter of credit lies in the effect that the farmer's status has on his position as lending risk. Tenants do not get credit because they cannot produce evidence of title to land or other assets and these form the basis of the loans given by official sources of credit.[1] As tenants form a large part of the category of small

1 The effect of tenurial conditions upon efficient production is a subject of great controversy in the literature on Indian agriculture. Khusro argued that disincentives arising from tenurial status like those arising from small size of farms are over-worked. Based on NSS data and Land Census data he showed that while a large proportion of rural households (50 per cent) suffered from tenurial disabilities, a smaller proportion of operated area was subject to similar disadvantages. Without indulging in a series of permutations of disincentives due to size and tenure aspects like Khusro, Dantwala arrives at much the same conclusion. More recently, Rudra analysed the results of FMS data for three states (West Bengal, Punjab and Andhra Pradesh) and showed how owner-cultivators and share-croppers managed their farms equally efficiently judging by their comparable input-output patterns. While these observations relate to the cultivation of traditional varieties of rice, Mukherjee analysed the situation with regard to HYV and found no empirical support for the claim that tenant-farmers suffered a handicap in the cultivation of the new varieties. Dissenters from this view are equally forceful. Reference has already been made to Ladejinsky's findings, refer Chapter I. Parthasarathy and Babu refute Mukherjee's view by pointing out that the latter failed to distinguish between pure tenants and owner cultivators. For the sources of these views, in order of mention, see the following: Khusro,A.M. 'Farm Size and Land Tenure in India.' The Indian Economic Review, IV, 2, Oct. 1969, pp 123-145; Dantwala,M.L. 'Small Farmers not Small Farms,' in Readings in Agricultural Development, op.cit., pp 418-421; Rudra,A. and Chakravarty.A. 'Economic Effects of Tenancy, some Negative Results,' EPW, VIII, 28, July 14, 1973, pp 1239-1247; Rudra,A. and Dwivedi,H. 'Economic Effects of Tenancy, some Further Negative Results,' EPW, VIII, 29, July 21, 1973, pp 1291-1294; Mukherjee,P.K. 'Higher-Yielding Varieties Programme - the Variables that Matter,' EPW, V, 22, March 28, 1970, pp A15-A22; Parthasarathy,G. and Babu,H.S. 'Higher-Yielding Varieties Programme - the Variables that Matter,' EPW, V, 25, June 29, 1970, p 986. In the midst of all the storm raised by the controversy one must recall Thorner's observation that "no matter how they are juggled into ratios, proportions and percentages," the Census data, for that matter, any other data on landholdings do not warrant the conclusion that tenurial and size dis-economies are not inimical to productivity, Thorner,D. 'India's Agrarian Revolution by Census Redefinition,' The Indian Economic Review, II, 3, Aug. 1966, pp 1-21.

farmers, the granting of credit facilities to them presupposes either the removal of tenurial disincentives or the reformulation of lending policies in a manner that by-passes security requirements. One is hard put to follow the suggestion of Minhas and Srinivasan that "the problem of credit and tenancy in their relationship to fertiliser use must be kept in distinct functional and analytical categories."[1] If anything, as Mitra argues, the problem of rural credit reflects the unfinished course of land reforms.[2]

The conclusion of this section is that low cash incomes and the high proportion of consumption expenditure to total expenditure of small farmers, combined with the additional production risks imposed by the new varieties on the seasonal rhythm of rice cultivation cause the demand for short term production credit to assume special importance.

1 Minhas, B.S. and Srinivasan, T.N. 'New Agricultural Production Strategies - some Policy Issues,' in Readings in Agricultural Development, op.cit., pp 173-185.

2 Mitra, A. 'Delivery and Distribution of Inputs of Agriculture to Small Farmers,' in Papers and Proceedings of the Workshop-cum-Seminar on Rural Institutions and Agricultural Development, edited by Khan, W. National Institute of Community Development, Hyderabad, p 53. Compare Worriner, D. Land and Poverty in the Middle East, London, 1948; "Land ownership is a credit operation, nothing more," p 5.

V.2. Estimation of Credit Requirements

Estimates of production credit are calculated by us on the basis of cash expenditure on variable inputs. Outlays in the cultivation of new varieties are in the nature of working capital requirements narrowly defined as work-in-progress.[1] The latter is defined as the value of pre-paid inputs i.e. expenses incurred before the sale of harvest.[2] The size of work-in-progress per unit of output depends upon the cost of recurring inputs and the time lag in their application. It is also related to the type of farm organisation.[3] Average working capital requirements can be expressed as the ratio of work-in-progress to net value added.[4]

1 The method used here is similar to that used by Sen in his calculation of working capital requirements for the Indian economy, Sen,A.K. 'Working Capital Requirements for the Indian Economy - A Conceptual Framework,' in Resenstein-Rodan,P.N. Pricing and Fiscal Policies - A Study in Method, George Allen & Unwin Ltd. Londom, 1964, pp 142-144.

2 This includes the values of the following inputs: hired labour, bullock labour, fertilisers, purchased seeds, irrigation charges. For computational and analytical reasons all imputed values are ignored.

3 Sen distinguishes between a wage-economy and a non-wage economy. In the former case the need for higher working capital requirements arises because of "labour in the pipe-line;" money wages which have to be paid to hired labour have to be included when calculating working capital requirements, Sen, A.K. 'Working Capital Requirements for the Indian Economy - A Conceptual Framework," op.cit., p 30.

4 Net value is calculated by deducting from the value of grain output the values of seeds, fertilisers and irrigation charges.

Table V.1 shows the cost of production of traditional and Higher-Yielding Varieties.[1] The definition of cost used in our analysis is the actual cost incurred in cash. As we mentioned earlier, it excludes all imputed values.[2] This exclusion means that our definition is more narrow than that used by both the Farm Management Surveys and reports of the Agro-Economic Research Centres.[3] The latter reports give the values of all inputs according to size distribution of farms, but as they include imputed values, we have calculated the values of all inputs by multiplying actual quantities purchased by the ruling prices.[4] A comparison of the total cost of production of the two varieties shows that the cost of cultivation of the new varieties was more than one and a half times

1 For a detailed break÷down of cost of production according to farm sizes see Appendix Tables XI and XII.

2 In India, 50 per cent of the cost of raising a crop are incurred in cash and kind and the remainder represents imputed values of self-supplied inputs. Different methods are used in the Studies in Farm Management in different states for arriving at these values. In Andhra Pradesh, for example, prevailing rents are used for calculating the value of land, while in states like Orissa and Bengal rental values on owned land are charged on the basis of 3 per cent interest on the capitalised value of land. Again, whereas in the latter states values of family labour is imputed on the basis of wage rates for casual labour, in Andhra Pradesh it is calculated in terms of the wages of permanent farm servants, Rice Economy of India, op.cit., p 97.

3 The Farm Management Survey distinguishes between four categories of costs, Cost A_1, Cost A_2, Cost C and Prime Cost; all cost categories include imputed values. The Reports for Kharif and Rabi use these categories; for descriptions of principal items of total cost, see Chapter III in both reports.

4 Our estimates are lower for yet another reason. As the reports do not give the break-down of costs such as tractor charges and rent these items have been excluded by us. On the whole our definition of cost corresponds to that used by the Technical Committee set up by the Reserve Bank of India for the Study of the Higher-Yielding Varieties Programme, see Report on the Higher-Yielding Varieties Programme - Studies in Eight Districts, op.cit., p 36.

Table V.1. Cost of Production of Traditional and Higher-Yielding Varieties of Rice according to Chief Items of Expenditure, West Godavary, Kharif (K) and Rabi (R) 1968-69.

Rupees per Acre

	Seeds	Farm Yard Manure	Fertiliser	Pesticide	Hired Human Labour	Hired Bullock Labour	Irrigation	Total
Traditional Varieties								
(K)	11.97(4%)	7.34(3%)	17.91(7%)	1.47(1%)	192.65(77%)	1.04(3%)	15.51(6%)	247.89(100%)
(R)	16.92(4%)	- (-)	158.56(39%)	12.25(3%)	204.38(52%)	0.14(-)	7.59(2%)	399.84(100%)
Higher-Yielding Varieties								
(K)	14.81(3%)	1.78(-)	138.87(32%)	16.05(16%)	228.91(53%)	1.01(-)	24.23(6%)	435.66(100%)
(R)	14.95(3%)	5.32(1%)	239.06(41%)	37.52(6%)	244.82(42%)	4.18(1%)	40.03(6%)	585.88(100%)

Source: Report for Kharif, op.cit., p 53.

Report for Rabi, op.cit., p 54.

that of the traditional varieties. Table V.1 also brings out the relative importance of the different inputs. Hired human labour is the most important input in the case of traditional varieties. They continue to be important in the cultivation of the new varieties in both seasons. Fertilisers assume importance in the cultivation of the new varieties being the second most important input especially in the Rabi season. To test the relationship between total cost per acre and farm size we regressed the former on the latter. The regression coefficient proved statistically insignificant at $r^2 = 0.06$. This suggests that there is no relation between the two variables.

We give three estimates of the total credit requirements of farmers cultivating the new varieties in West Godavary in Table V.2. The first estimate is based on actual cash expenditure per acre by all size classes of farms. The second estimate is also based on actual cash expenditure making allowances for farmers' own resources.[1] The first estimate is hypothetical as it assumes that all farmers need to borrow to finance the cultivation of the new varieties. As we know all farm sizes financed part of increased production costs from own resources, the second estimate is a more realistic one.[2] The third estimate takes into account credit requirements for both production and consumption. Credit requirements for the latter are arrived at by adding to the second estimate the value of the amount of output retained for self-consumption.[3] The

1 The exact source or nature of own funds cannot be gathered from the data, that is, we do not know whether these funds are comprised of savings, value of the sale of assets, etc. In every case "own resources" refer to the proportion of the value of purchased inputs financed by farmers own financial resources and do not mean imputed values. These proportions are given in Appendix Table VII.

2 To test the nature of the relationship between the proportion of total cost borrowed and farm size a regression equation was fitted between the two variables. The correlation coefficient (at $r^2=0.54$) has a highly significant negative value of -0.54. An almost similar negative value (-0.53) was noted in the case of traditional varieties. The number of observations was 20 in both cases with t-values greater than 2.5. The important influence of owned funds on the relationship between credit and farm size was observed by Prasad in his analysis of the very data we based our calculations on, Prasad, D.S. 'The New Technology in Rice, Institutional Credit and the Small Farmer - An Analysis of Empirical Studies, <u>IJAE</u>, XXVI, 4, Oct. Dec. 1971, p 563.

3 As our data does not contain any information on consumption, these proportions are taken from George, P.S. and Choukidar, V.V. <u>Production and Marketing Pattern of Paddy</u>, <u>op.cit.</u>, pp 126-128. Some adjustments have been made by us to make the classification of farms in the two comparable.

Table V.2. Estimates of Demand for Credit - West Godavary, 1968-69.

Rupees

Farm Size (acres)	Estimate I	Estimate II	Estimate III
Kharif			
Below 5.00	6245.68	3240.96	12430.31
5.01 - 10.00	14559.76	5201.25	12139.08
10.01 - 15.00	9099.17	1066.06	7108.26
15.01 - 20.00	3154.22	2090.19	4886.57
20.01 & Above	76207.42	15507.32	17443.63
Rabi			
Below 5.00	10360.88	5585.15	7950.07
5.01 - 10.00	11132.11	6188.66	6188.66
10.01 - 15.00	7361.79	2547.00	2946.00
15.01 - 20.00	8500.25	863.00	863.00
20.01 & Above	10840.70	96.71	1606.78
Total	157461.98	42386.30	66510.71

Source: Appendix Table VII and George, P.S. and Choukidar, V.V. Production and Marketing Pattern of Paddy, op.cit., pp 126-128.

total credit requirement for the district as a whole is got by adding up the requirements of each size class for each of the three cases.

All this involves rather wild guesswork! Given the nature of the available data and the unavoidably rickety assumptions one is forced to make under the circumstances, all that is claimed is that these estimates give an idea of the likely order of the magnitude of credit requirements on our sample farms.[1] These will be matched with the actual amounts of credit given by co-operatives to determine the inadequacy or otherwise of institutional credit in West Godavary.

The above estimates are based on credit requirements per acre. It is also possible to calculate credit requirements per unit of income. There are two possible measurements here, namely average working capital requirements and marginal or incremental working capital requirements. Average working capital requirements can be expressed as the ratio of work-in-progress to net value added.[2] Although both concepts have implications for credit policy, we have to confine our attention to the systematic variation in average working capital requirement and farm size because the marginal coefficients of working capital requirements calculated by us are not statistically significant. Marginal coefficient of working capital for HYV was calculated by using the formula for elasticity (Elasticity $X_i = b_i \frac{\bar{x}}{\bar{y}}$, where x and y refer to the statistical means of net value added and working capital respectively.) The regression coefficient being very small (0.0017) and statistically non-significant the marginal coefficient is not reproduced here. The regression of working capital on net value added for traditional varieties also yielded poor results. The total number of observations in both cases was 20.

1 Caution about drawing conclusions from one year's figures for so small a sample cannot be over-emphasised.

2 For definition see above p 224.

Table V.3. gives the average working capital requirements according to farm size for the two seasons. From it we gather that there is a great deal of variety in the figures there being no consistent pattern according to farm size, varieties or even seasons. The negative figure needs some explanation. It appears because the net value added by the cultivation of traditional varieties on farms of 20 acres and above is negative. The average working capital requirement for HYV for all farms for the two seasons are, respectively, 1.26 and 0.80. This means that if the district wants to increase net income by 1 per cent, it would have to acquire working capital equivalent to 1.26 per cent and 0.80 per cent of this net income in the respective seasons.

Inter-farm requirements are not without interest, particularly the farm size 5.01 to 10.00 acres. This size has the highest working capital requirement in both seasons. Is this a confirmation of higher working capital requirement on farms of this size? To test how plausible this is, regression equations were fitted between working capital requirements and farm size in the case of both varieties.[1] The results showed a positive not strong correlation between the two variables.[2] When we combine these results with those that show no relation at all between total cash expenditure on farms cultivating HYV and farm size,[3] we are led to conclude that there is no correlation between expenditure per acre on the cultivation of HYV and farm size. Armed with knowledge (of a sort) we can proceed to see what implications this has for credit policy.

1 As in the other equations observations for East Godavary were thrown in to enlarge the size of the sample.

2 The regression equations for both varieties are reproduced below:

Variety	Constant	Regression Coefficient	r^2	t-value	Number of Observations	Significance level
HYV	0.021	0.06	0.38	1.74	20	5%
Traditional	0.633	-0.02	0.18	0.76	20	5%

A regression equation fitted for data from FMS for traditional varieties showed no correlation between working capital requirement and farm size.

3 Refer above, p 227.

Table V.3. Average Working Capital Requirements - Traditional and Higher-Yielding Varieties, West Godavary, 1968-69

Percentages

Farm Size (acres)	Average Working Capital	
	Traditional Varieties	Higher-Yielding Varieties
Kharif		
Below 5.00	0.18	0.66
5.01 - 10.00	0.33	2.92
10.01 - 15.00	3.66	0.51
15.01 - 20.00	2.16	0.41
20.01 & Above	-1.27	0.82
Rabi		
Below 5.00	0.01	0.87
5.01 - 10.00	0.10	1.16
10.01 - 15.00	0.58	0.58
15.01 - 20.00	0.27	0.48
20.01 & Above	0.23	0.91

Source: Appendix Tables VII and IX.

Note: Average Working Capital is defined as the ratio of work-in-progress to net value added. Work-in-progress refers to expenses incurred before the sale of harvest. Net value added has been calculated by deducting from the value of grain output the values of seeds, fertilisers, and irrigation charges.

V.3. Sources of Credit Supply : Cooperatives

The sources of agricultural credit can be classified into two broad categories : private agencies consisting of moneylenders, traders, relatives, etc. and institutional agencies like commercial banks and co-operatives. According to the All-India Rural Debt and Investment Survey the contribution of the different agencies to the total supply of credit in Andhra Pradesh in 1961-62 is as follows:[1]

Government	0.5
Cooperatives	12.7
Relatives	1.6
Landlords	0.4
Agriculturist Moneylender	59.3
Professional Moneylender	9.6
Traders & Commission Agents	10.2
Commercial Banks	1.5
Others	4.2
	100.0

In our study of credit supply in relation to HYVP only two sources have been selected, the cooperatives which account for the institutional sources of credit[2] and agricultural moneylenders who account for the highest percentage among non-institutional sources.[3] The selection is justified on the grounds

1 Reserve Bank of India, 'All-India Rural Debt and Investment Survey,' Reserve Bank of India Bulletin, XIX, 9, Sept. 1965, pp 1299-1318.

2 The share of cooperatives in the total supply of credit in Andhra Pradesh is lower than their share in the total supply of credit for the whole of India, the latter being 15.5 per cent, ibid.

3 Next to Bihar, moneylenders accounted for the highest share of total credit supply in Andhra Pradesh compared to other states in India, ibid.

that these two agencies are representative of organised and un-organised money markets respectively and their relative importance in the provision of production credit and consumption credit highlights the many facets of the credit problem in relation to the new strategy. Furthermore, Cooperative Credit Agencies are the principal distribution agencies for the new inputs and are responsible for the disbursement of funds specially allocated by the Reserve Bank for the implementation of HYVP.[1] The role of the agricultural money-lender and his importance in the supply of credit is discussed in the next section. Here we explore the role of cooperatives, but first we shall take a brief look at the evolution of credit policy under the new strategy.

Credit policy under HYVP has evolved out of that under the Intensive Agricultural District Programme. Although the All-India Rural Credit Survey designed the framework of the Integrated Scheme of Rural Credit around the cooperatives as the pivotal agency, before the introduction of the IADP there was no dirrect connection between the loan policies of the Central Cooperative Banks which sanctioned short and medium term loans for seasonal operations and the Agricultural Departments of the State Governments. The missing link was provided by the rationalisation of loan policies under the IADP and the making of funds available by the Reserve Bank for the implementation of agricultural programmes. For cultivators participating in the HYVP but outside the cooperative fold, arrangements exist for the supply of funds through Agricultural Departments of individual states. Other aspects of credit policy under the new strategy are the preparation of farm plans and the compulsory lifting of fertilisers in kind. Like the arrangement under the Package Programme, the required quantity of each input on individual farms and the credit necessary to acquire them is laid down in production plans drawn up by Village Level Workers.[2]

1 Administrative Reforms Commission, Report of the Study Team on Agricultural Administration, 1967, Vol. I, op.cit., pp 164-167.

2 Reserve Bank of India, Studies in Agricultural Credit, Bombay, 1970, pp 4 & 55; Programme Evaluation Organisation, Evaluation Study of the High-Yielding Varieties Programme, Report for Kharif, 1967, New Delhi, August 1968, pp 51-54.

In the initial years of the introduction of HYVP, special credit facilities were made available to cultivators in all states through higher credit limits sanctioned by the Reserve Bank of India.[1] But the utilisation of such special credits being very low in most of the States, the Reserve Bank withdrew this shceme, supplementary credit being made available to State Co-operative Banks when the latter exhausted their normal limits. Of the total amount allotted to the cooperative sector in Andhra Pradesh in Kharif and Rabi, the amount of funds disbursed were respectively, 22 per cent and 9 per cent. The reasons for this were partly the inefficiency of the system of administration and partly the incorrect formulation of farm production plans.[2]

Returning to the role of cooperatives in the supply of agricultural credit in Andhra Pradesh it is appropriate to start with a reference to the structure of cooperative agencies. The cooperative credit structure for short term and medium term credit is the three tier federal one with the State Co-operative Bank at the apex, the Central Cooperative Bank at the district level and the Primary Credit Societies at the base. The progress of cooperation in Andhra Pradesh has been unsatisfactory.[3] Heavy overdues and defaults at various levels of the cooperative structure, poor deposit levels and the consequent inability to use the full credit limits sanctioned by the Reserve Bank

1 The social control of commercial banks and the laying down of guidelines for the financing of agriculture by them are new developments on the rural credit scene. For a comprehensive survey of the different aspects of financing of agriculture by commercial banks see Reserve Bank of India, Financing of Agriculture by Commercial Banks, Bombay, February 1969. Ghatak regards these developments as one of the factors contributing to the integration of the organised and non-organised sectors of the rural money market. He bases his observation on the study of rural money markets in India in the 1950's and 1960's. Ghatak, S. Rural Money Markets in India (Unpublished PhD thesis), London University, 1972, Chapter V.

2 Report of the Evaluation of the High-Yielding Varieties Programme, Report for Kharif, 1967, op.cit., pp 51-54; Report for Kharif, 1968, op.cit., pp 32-37.

3 National Credit Council, Organisational Framework for the Implementation of Social Objectives - Report of A Study Group of the National Credit Council, Bombay, October 1969, p 15; Parthasarathy, G. Green Revolution and the Weaker Section, Thacker and Company Ltd., Bombay, 1971, Chapter V, pp 35-41.

are some of the reasons ascribed by the All-India Rural Credit Review Committee for the poor development of cooperation in the state.[1] Between 1967-68 and 1969-70 the volume of credit made available by the Central Cooperative Banks actually declined by 15 per cent, from Rs 40.3 crores to Rs 34.3 crores.[2] A comparison of the cooperative structures in Punjab, Hayarana and Andhra Pradesh in terms of some selected indices serves to bring out the general backwardness of the cooperative structure in our state. The comparison is presented in Table V.4.

Table V.4. Comparison of the Central Cooperative Banks in Andhra Pradesh Punjab and Harayana in Terms of Some Selected Indicators - 1970

	Andhra Pradesh	Punjab	Harayana
Average Deposits per 100 of Population	Rs 404	Rs 1932	Rs 855
Total loans advanced during year ended June 1970	Rs 34.3 crs.	Rs 72.7 crs.	Rs 17.3
Average loans issued per capita	Rs 10	Rs 287.5	Rs 22
Overdues as percentage of loans outstanding	34.2	31.5	36.6
Percentage of total credits sanctioned by Reserve Bank actually withdrawn (1969-70)	96.00	87.00	79.00

Source: Reserve Bank of India, Review of the Cooperative Movement in India, op.cit., pp 58, 61 & 24.

1 RAIRCRC, op.cit., pp 203-209.

2 Reserve Bank of India, Review of the Cooperative Movement in India, 1968-70, Bombay, 1972, p 57.

Viewing the performance of Primary Agricultural Societies in Andhra Pradesh we notice a similar backwardness in development. A survey undertaken by the Reserve Bank of India as a prelude to the reorganisation of primary credit societies revealed that only 2 per cent of the total number in the state were financially viable.[1] Again, a comparison with Punjab and Harayana in terms of some selected indicators brings out the general features of this sector of the cooperative structure, Table V.5.

Table V.5. Comparison of Primary Agricultural Credit Societies in Andhra Pradesh, Punjab and Harayana in Terms of Some Selected Indicators - 1970

	Andhra Pradesh	Punjab	Harayana
Number of Societies	14916	10358	6178
Dormant Societies as % of total	16.8	0.8	2.8
Percentage of Villages covered by active Societies	85.3	99.4	97.4
Average loan per borrowing member (1969 - 70)	Rs 299	Rs 459	Rs 459
Overdues as % of Outstandings (1969 - 70)	43.00	39.00	33.00

Source: Review of Cooperative Movement in India, 1968-70, op.cit., pp 67, 68, 74 & 77.

1 Review of the Cooperative Movement in India, 1968-70, op.cit., p 80; RAIRCRC, op.cit., pp 204-209. For a detailed discussion of the factors making for the non-viability of cooperative societies, see Ghatak, S. Rural Money Markets in India, op.cit., pp 172-176.

The pattern of supply of credit by cooperative societies and private moneylenders on our sample farms is presented in Table V.6. In the Kharif season 36 per cent of the total number participants borrowed from cooperatives and 25 per cent from private moneylenders.[1] The corresponding figures for Rabi are 23 per cent and 37 per cent. The Kharif figures show that the percentage of cultivators borrowing from cooperatives was higher in the large size category than the small size one. The two smallest size-classes of farms borrowed proportionately more from private moneylenders than from cooperatives.[2] The amount borrowed per acre was highest for the smallest farm size in the case of loans taken from both sources. In the Rabi season there is a marked dependence on private moneylenders both in terms of the number of cultivators applying to them for loans and the actual amounts borrowed in the case of small farms.

As far as the pattern of utilisation is concerned, expenditure on seasonal agricultural formed more than 90 per cent of short-term loans taken from cooperatives in the Kharif season, Table V.7. More than 60 per cent of loans taken from private moneylenders was used to finance seasonal operations.[3] Loans, taken from both sources, were primarily used for the purchase of fertilisers and the hiring of human labour inputs. In the Rabi season, loans taken predominantly from private moneylenders were used to finance the purchase of these inputs. Tables V.6 and V.7, taken together, serve to establish the fact that cooperative loans tend to flow to large farmers and that small farmers borrowed proportionately more from private moneylenders. Borrowings per acre according to farm size suggest at first sight that working capital requirements on small farms are higher than on large farms.

1 It is difficult to tell from our data whether private moneylenders refer to moneylenders proper or agriculturist moneylenders.

2 This could be a reflection of the greater consumption needs of such farms, during this season, see ARCS, Follow-up Survey 1959-60, Bombay, 1962, pp59-60.

3 Report for Kharif, 1968-69 and Report for Rabi 1968-69, op.cit., pp 65-69 & 55-58 respectively. For the state as a whole, in recent times (1970-71) seasonal agricultural operations account for 80 per cent of the loans taken from cooperatives, Reserve Bank of India, Statistical Statement Relating to the Cooperative Movement in India, 1970-71, (Part I), Bombay, pp 12, 24 & 101.

Table V.6. Supply of Credit through Cooperative Societies & Moneylenders, West Godavary, Kharif & Rabi, 1968-69

Farm Size (acres)	Number of Selected Cultivators	Number of Cultivators Raising Loans Through		Total Amount Borrowed		Amount Borrowed per Acre of Area under HYVP & Trad. Paddy	
		Cooperatives	Moneylenders	Cooperatives Rs.	Moneylenders Rs.	Cooperatives Rs.	Moneylenders Rs.
1	2	3	4	5	6	7	8
Kharif							
Below 5.00	12	3(25)	8(67)	3115.00(7.00)	3279.50(20.00)	285.78	169.48
5.01 - 10.00	11	3(27)	4(36)	2040.00(4.00)	3603.75(22.00)	94.88	155.54
10.01 - 15.00	11	4(36)	1(9)	3600.00(8.00)	2420.00(14.00)	88.65	201.67
15.01 - 20.00	5	2(40)	-	2100.00(5.00)	-	58.66	-
2.01 & Above	21	10(48)	2(10)	34700.00(76.00)	7424.00(44.00)	108.07	164.98
TOTAL	60	22(37)	15(25)	45555.00	16727.25	105.96	168.08
Rabi							
Below 5.00	14	1(7)	13(93)	90(1.00)	8000.50(39.00)	3.42	302.71
5.01 - 10.00	8	1(12)	7(88)	1000(17.00)	8778.67(42.00)	27.86	244.53
10.01 - 15.00	4	2(50)	1(25)	2935(49.00)	2665.00(13.00)	80.85	73.42
15.01 - 20.00	2	2(100)	1(50)	1500(25.00)	1320.00(6.00)	67.08	59.03
20.01 & Above	2	1(50)	-	500(8.00)	-	17.24	-
TOTAL	30	7(23)	22(73)	6025	20764.17	40.17	138.44

Source: Report for Kharif, 1968-69, op.cit., p Appendix Table No.46. Report for Rabi, 1968-69, op.cit., p Appendix Table No.34.

Note: Figures in brackets under columns 3 & 4 refer to cultivators borrowing from cooperatives and moneylenders as percentage of total number of selected cultivators.

Figures in brackets under columns 5 & 6 refer to total amount borrowed by each size-class as a percentage of total amount borrowed from cooperatives and moneylenders by all size-classes of farms.

Table V.7. Utilisation of Loans Borrowed from Cooperative Societies and Private Moneylenders according to Farm Size, West Godavary - Kharif and Rabi, 1968-69 (Rs per Acre)

Farm Size (acres)	Seeds		Fertilisers		Pesticides		Hired Human Labour		Hired Bullock Labour		Total	
	Co-ops.	Money-lender	Co-ops.	Money-lender	Co-ops.	Money-lender	Co-ops.	Money-lender	Co-ops.	Money-lender	Co-ops.	Money-lender
1	2	3	4	5	6	7	8	9	10	11	12	13
Below 5.00	5.00 (3.00)	0.65 (1)	58.62 (39.00)	5.00 (8.00)	6.39 (4.00)	0.45 (1)	84.06 (54.00)	51.49 (82.00)	0.78 (1)	3.44 (6.00)	154.85 (100.00)	61.62 (100.00)
5.01-10.00	-	-	10.63 (46.00)	38.91 (64)	1.03 (4.00)	0.66 (1.00)	11.46 (49.00)	21.39 (35)	-	-	23.12 (100.00)	60.96 (100.00)
10.01-15.00	-	-	19.73 (45.00)	-	1.59 (3.00)	-	21.23 (48.00)	-	1.70 (4.00)		44.25 (100.00)	-
15.01-20.00	1.92 (2.80)	-	62.02 (58.00)	-	2.98 (3.8)	-	38.85 (37.7)	-	-	-	105.77 (100.00)	-
20.01 & Above	1.59 (2.00)	-	24.78 (32.00)	9.44 (93.00)	2.58 (3.00)	0.66 (6.00)	49.08 (63.00)	-	-	-	78.03 (100.00)	10.10 (100.00)
All	1.58 (2.00)	0.04	27.15 (35.00)	9.73 (65.00)	2.65 (3.00)	0.56 (4.00)	46.04 (59.00)	4.53 (30.00)	0.20	0.21 (1.00)	77.62 (100.00)	15.07 (100.00)

Table V.7. (continued)

Farm Size (acres)	Seeds		Fertilisers		Pesticides		Hired Human Labour		Hired Bullock Labour		Total	
	Co-ops.	Money-lender	Co-ops.	Money-lender	Co-ops.	Money lender	Co-ops.	Money-lender	Co-ops.	Money-lender	Co-ops.	Money-lender
1	2	3	4	5	6	7	8	9	10	11	12	13
Below 5.00	-	3.97 (2.00)	4.70 (100.00)	152.62 (58.00)	-	17.52 (7.00)	-	84.84 (33.00)	-	1.46 (1.00)	4.70 (100.00)	260.36 (100.00
5.00-10.00	-	0.59	-	198.96 (65.00)	-	34.31 (11.00)	-	73.32 (24.00)	-	-	-	307.18 (100.00
10.01-15.00	6.96 (7.37)	-	87.36 (93.00)	-	-	-	-	78.24 (100.00)	-	-	94.32 (100.00)	78.24 (100.00
15.01-20.00	-	-	50.80 (100.00)	-	-	-	-	9.20 (100.00)	-	-	50.80 (100.00)	9.20 (100.00
20.01 & Above	-	-	-	-	-	-	-	-	-	-	-	-
All	1.14 (5.00)	1.15 (1.00)	23.71 (95.00)	90.55 (56.00)	-	13.42 (8.00)	-	54.78 (34.00)	-	0.37	24.85 (100.00)	160.27 (100.00

Source: (1) Report for Kharif, 1968-69, pp 28, 34, 40. (2) Report for Rabi, 1968-69, pp 22, 26, 28, 30, 32.

Note: Figures in brackets indicate percentage to total amount borrowed from cooperatives and private moneylenders.

The bigger share of large farmers in the total supply of cooperative credit is not peculiar to our sample farms or even to the state at large. The Study of the Utilisation of Cooperative Loans had this to say about the distribution of cooperative credit :

> "Of the credit given in 1960-61, 96 per cent went to cultivators and only 4 per cent to others. The share of credit obtained by the cultivators shows a progressive increase with the rise in the size of the holdings. Only about 15 per cent of credit had gone to members having 5 acres as against 39 per cent to those between 5 to 10 acres and 46 per cent to still larger cultivators."[1]

Evidence of this tendency is available from a variety of sources both official and non-official. The Reserve Bank of India reported that the proportion of borrowings declined with the decrease in the size of holdings.[2] Agricultural labourers and tenants who comprise small farmers are excluded from the credit facilities offered by cooperatives. Various studies undertaken in the different parts of the country have shown that although decisions are taken at conferences organised by the central cooperative banks which make it possible for the cooperatives to give loans to tenants, in actual practice the tenants' entitlement to credit is restricted to a sum of Rs 250. Even membership is denied to certain classes of cultivators even though provision exists for such people to apply to the Registrar of Cooperative Societies for redress.[3] Nor can tenants expect a better deal under the Crop Loan System.[4] Under this system the borrower has to declare the Khasra number of the plot

1 Government of India, Planning Commission, Programme Evaluation Organisation, Study of Utilisation of Cooperative Loans, Publication No. 49, New Delhi, 1965, p 132. Organisational Framework for the Implementation of Social Objectives, op.cit., pp 46-47.

2 Studies in Agricultural Credit, op.cit., p 85.

3 RAIRCRC, op.cit., p 174.

4 Fourth Five Year Plan - A Draft Outline, op.cit., p 136. For details of this system see Section V.5 below.

cultivated by him. A large number of share-croppers would not be entitled to any credit as the landlords would not allow them to disclose the plot numbers.[1] Thus, despite the various measures taken by the Reserve Bank of India to aid the cooperative movement in its aims to provide credit to all sections of the rural population, the share of tenant cultivators and agricultural labourers in the total supply of credit is very meagre as can be seen from Table V.8.

Table V.8. Loans issued by Agricultural Credit Societies by Size of Ownership Holdings, Andhra Pradesh, 1970-71

Size of Farms (acres)	Amount '000 Rupees	As Percentage of Total Loan issued
Below 2.5	55171	19
2.5 - 5.00	57930	20
5.01 - 10.00	60635	21
10.01 - 20.00	60075	20
20.01 & Above	44741	16
Tenant Cultivators	4542	2
Agricultural Labourers	4066	1
Others	321	0
Total	287481	100

Source: Statistical Statements Relating to the Cooperative Movement in India, 1970-71, Part I, (Credit Societies), op.cit., p 104.

1 Ladejinsky, A Study of Tenurial Conditions in the Package Districts, op.cit., pp 20-26; Parthasarathy, S. Agricultural Development and Small Farmers - A Study of Andhra Pradesh, op.cit., pp 57-58.

Restrictive practices and the insistence on the security of mortgage of land are responsible for the unfavourable treatment of small farmers in the distribution of cooperative credit.[1] Our hypothesis is that the borrowing power of small farmers is limited by the size of assets[2] they hold, especially the value of owned land.[3] The inequality in the distribution of assets in Andhra Pradesh, which incidentally is the highest in India, and the inequality in the distribution of cooperative loans were calculated by the Reserve Bank of India by means of Lorenz Curves. The coefficient of correlation in both cases was the same, being 0.88.[4] Table V.9 shows the two

1 The various factors which prevent small farmers from acquiring loans have been listed by the AIRCRC, op.cit., p 174 and have since been reiterated by a number of writers like Lele,U.M. Role of Credit and Marketing Function in Agricultural Development, International Bank for Reconstruction and Development, Washington D.C. 1972. The way in which cooperative societies preempt tenants and agricultural labourers in Andhra Pradesh can be seen from the fact that some cooperatives make repayment capacity a condition of eligibility for membership, Parthasarathy,G. Agricultural Development and Small Farmers - A Study of Andhra Pradesh, op.cit., pp 81-83. The situation in Andhra Pradesh contrasts sharply with that in Pubjab where societies insist only on proof of cultivation, Lateef,S. 'Missing - A Strategy,' Seminar, No. 129,1970, pp 28-30.

2 By assets is meant land, residential buildings, livestock, implements, durable household assets (gold and bullion), dues on advances and loans, securities; excluded from the concept are cash in hand and insurance policies.

3 The importance of land in the total value of assets can be seen from the percentage break-down of the constituent items:

Average Value of Assets	Total Immovable Property: Land	Total Immovable Property: Buildings	Total Immovable Property: Total	Livestock	Durable Household Assets	Transport Equipment: Farm & Non-Farm	Dues recd. (cash & kind)	Financial Assets
Rs5779	67.9	16.4	84.3	6.0	4.9	2.1	2.4	0.3

Source: Reserve Bank of India Bulletin, Oct. 1966, op.cit., pp 1180.

4 RAIRCRC, op.cit., p 130.

Table V.9. Percentage Distribution of Rural Households according to the Value of Assets and the Share of each Asset Group in the Total Value of Assets and the Total Amount of Loans given by Cooperatives, Andhra Pradesh, 1961-62.

Asset Group	Proportion of Households	Share of Asset Group	Share of Cooperative Loans
1	2	3	4
Less than 500	25.1	1.0	0.9
500 - 1000	14.0	1.8	0.7
1000 - 2500	20.6	5.9	5.2
2500 - 5000	15.3	9.5	6.8
5000 - 10000	11.0	13.6	12.3
10000 - 20000	7.8	19.0	2.0
20000 & Above	6.2	49.2	53.1
	100.00	100.00	100.00

Source: Murdeshwar, A.P. (Prepared by) 'Distribution of Value of Total Assets Among Households Resident in the Rural Sector of India,' Reserve Bank of India Bulletin, XX, 10, Oct. 1966, pp 1179-1186.

distributions according to different asset groups.

Admittedly, the equality of concentration ratios does not necessarily imply that the two distributions under consideration are identical. To find out more about the distribution of assets and households, the shape of the Lorenz Curve has to be analysed in terms of the departure of the curve from the line of perfect equality. Such an analysis revealed that in Andhra Pradesh the top 10 per cent of the households accounted for 60 per cent of the total value of assets.[1]

1 RBIB, Oct. 1966, op.cit., p 1184. Ghatak provides us with some empirical evidence here with reference to All-India in the 1950's and 1960's. Basing his calculations on the data provided by the ARCS, he found a strong positive correlation between borrowing, indebtedness and value of assets, Ghatak, S. Rural Money Markets in India, op.cit., pp 88-91.

Although the ARCS had recommended that short-term credit should be divorced from security requirements and that cooperatives should instead make a statutory change on the crop to buttress personal surety, the Committee on Cooperative Credit found from a review of the situation in 1960 that the basis of lending had not changed.[1] The chief beneficiaries of cooperative credit continued to be farmers with assets. This is all the more depressing because, according to various Cooperative Societies Acts, cooperatives are required to give loans against the security of crops cultivated rather than the security of land.[2] Of the total loans given by Primary Cooperative Societies in Andhra Pradesh in 1971, 48 per cent was given against the security of immovable property and 46 per cent against personal surety. Loans against anticipated crop output constituted a mere 2 per cent.[3] The maximum limit on loans on the basis of personal surety lies in the range of Rs 500 and Rs 740.[4] Ironically, in some states persons standing as surety have to be landowners! Referring back to the disadvantages faced by share-croppers in obtaining cooperative credit, we see how this final requirement for obtaining cooperative loans virtually puts tenants in a cleftstick.

The chief concern in our study of the supply of cooperative credit is to show how small farmers are excluded by virtue of the asset-based lending policy of cooperatives. We hope to show later on how this in turn affects their ability to adopt the new varieties for cultivation. As a first step we tried to establish the relationship between the distribution of assets

1 Government of India, Report of the Committee on Cooperative Credit, New Delhi, 1960, p 85.

2 RAIRCRC, op.cit., p 486; ARCS, Vol. II, The General Report, op.cit., p 234. Yet another adverse effect of asset-based lending is that if farmers have to furnish immovable property for short-term finance they have nothing to offer by way of security for medium-term and long-term credit.

3 Statistical Statements Relating to the Cooperative Movement in India, 1970-71, op.cit., p 105.

4 RAIRCRC, op.cit., p 485.

among rural households in Andhra Pradesh and the distribution of cooperative loans. As we wish to show the association between the supply of credit and size of farms we have to find first the relationship between levels of assets and farm size. Finding this is not easy as the information has to be pieced together, using, at times, national data. Tables V.10 and V.11 give an idea

Table V.10. Average Borrowings according to Size of Assets, Andhra Pradesh, 1961-62

Asset Group	Average Amount Borrowed Family	Loans from Cooperatives		Average area personally cultivated per cultivator household	Average Borrowings per Acre
		Amount	As per cent of Average Amount Borrowed		
1	2	3	4	5	6
Less than 500	66.8	3.4	5.00	1.27	1.81
500 - 1000	95.5	2.1	2.19	2.14	2.38
1000 - 2500	147.8	7.6	5.14	3.35	2.81
2500 - 5000	185.1	11.9	6.42	5.35	3.66
5000 - 10000	284.0	28.8	10.14	8.06	4.42
10000 - 20000	455.8	66.2	14.52	11.86	5.36
20000 & Above	1061.8	213.8	20.13	23.26	7.33
All Assets	275.9	35.1	12.72	6.63	4.81

Source: Columns 2 & 3 - Organisational Framework for the Implementation of Social Objectives, op.cit., p A389.
Columns 5 & 6 - All-India Rural Credit Review Committee, op.cit., p 128.

Table V.11. Value of Assets, Membership of Cooperatives, Cooperative Loans and Farm Size, West Godavary, Kharif and Rabi, 1968-69

Value of Farm Assets (Rs)	Size of Farms Average (acres)	Membership of Cooperative Societies as Percentage of Total Number of Cultivators	Percentage of Membership actually raising Loans through Cooperatives	Total Amount Borrowed (Rs)	Total Amount Borrowed per Acre (Rs)*
1	2	3	4	5	6
322.91	3.34 (3.46)	50.00	25.00	3115.00	285.78
1704.54	6.87 (6.50)	81.82	27.27	2040.00	94.88
2350.91	12.09 (11.49)	90.91	36.36	3600.00	88.65
5390.00	17.33 (7.49)	80.00	40.00	2100.00	58.66
10397.15	39.14 (71.03)	90.48	47.62	34700.00	108.07
430.71	2.58 (16.08)	78.57	7.14	90.00	122.42
627.50	6.98 (24.87)	87.50	12.50	1000.00	117.57
3605.00	13.04 (23.23)	100.00	50.00	2935.00	202.78
350.00	16.10 (14.34)	100.00	100.00	1500.00	43.74
4845.00	24.10 (21.47)	100.00	50.00	500.00	73.30

Source: (1) Report on the Study of the High-Yielding Varieties Programme, Kharif 1968-69, *op.cit.*, pp 6,17,25, Appendix Table 46.
(2) Report on the Study of the High-Yielding Varieties Programme, Rabi 1968-69, *op.cit.*, pp 7, 21, 30, Appendix Table 34

Note: * Figures include borrowings for traditional varieties as well. Figures in brackets indicate percentage to total.

of the situation existing in 1961-62 and 1968-69 respectively. The former shows a consistent rise in the level of assets and in the area personally cultivated by farmers. The latter shows no such trend.

As no firm conclusion regarding the relationship between levels of assets and farm size could be drawn on the basis of the data in Tables V.10 and V.11, we tried to establish whether there is any systematic variation between the two by fitting a regression equation using data from the FMS, West Godavary. A total of 24 observations was obtained by combining time series and cross-section data.[1] The regression equation was :

$$Y = 1828.53 + 72.43X \qquad R^2 = 0.59$$

where Y is the value of assets and X the average size of farms. The regression coefficient is statistically significant at 1 per cent level. Thus, we see a strong positive correlation between value of assets and farm size and this lends credence, however tenuously, to the hypothesis we set about testing in this chapter, namely the supply of cooperative credit varies directly with the size of farms.

1 Studies in the Economics of Farm Management, West Godavary (Andhra Pradesh) 1957-58, 1958-59 and 1959-60, op.cit., pp 17 & 38, pp 7 & 17 and pp 13 & 39 respectively.

V.4. Supply of Credit : Agriculturist Moneylenders

In the previous section we established that small farmers borrowed proportionately more from private moneylenders and that large farmers were the chief beneficiaries of cooperative credit. The relative importance of these two sources of credit supply for the two categories of farmers can be traced to the relative importance of consumption and production credit on small farms and large farms. While a case can be made for the use of credit for consumption purposes on small farms, a parallel one for production credit cannot be made for large farms. Although large farms borrow money from co-operatives allegedly for production purposes, the loans they secure are not used entirely for this purpose. Deprecating asset-based lending, the ARCS had cautioned that under such a system of lending, farms with high levels of of assets will be able to secure loans for purposes other than production.[1] This fear has been more than confirmed by the advent of the prosperous farmers as moneylenders in their own right - "the agriculturist moneylender." The agriculturist moneylender is the big farmer who borrows from the co-operative societies to the maximum limits permitted by his assets and re-invests it in moneylending. The AIRDIS refers to agriculturist moneylenders as the most important source of credit in 1961-62. Whereas they accounted for only 25 per cent of total rural credit in 1952-52, they supplied 36 per cent in 1961-62[2] (All-India). In Andhra Pradesh they supplied nearly 60 per cent of the total rural credit supply.[3]

1 ARCS, Vol. II, The General Report, op.cit., p 234.

2 AIRDIS, op.cit., pp 1299-1318. Agriculturist moneylenders along with private moneylenders continue to be the chief source of supply of credit in recent times, Bhargava, P.K. & Jain, A.K. 'Changing Structure of Agricultural Finance in India,' ASI, XXV, 8, Nov. 1970, pp 829-825.

3 AIRDIS, op.cit., pp 1299-1318.

The distinction between the agricultural moneylender and professional moneylender depends upon whether they earn a substantial part of their income from farming or moneylending. As the former are not likely to divulge the extent of their moneylending activity, the extent of their activity is a debtors' assessment and this is subject to bias in reporting. It is also possible that professional moneylenders resumed personal cultivation, therefore adding to the ranks of agriculturist moneylenders. Although there is no hard evidence of the extent of loans made by large farmers to small farmers, the use of "own funds" by the large farms to finance the cultivation of the new varieties suggests that surplus funds at the disposal of large farmers might have been invested in moneylending.[1] We have some empirical support here with regard to HYV. From a study of HYVP in several districts, Mukherjee found that substantial surplus funds were generated in a matter of just two crop seasons and this enabled farmers to either re-invest it in their own farms or lend to others.[2] Other indications are the failure of deposits in cooperative societies to increase and the extent and growth of overdues at various levels of the cooperative structure.

Deposits of cooperative societies in West Godavary actually declined by 33 per cent between 1967-68 and 1968-69.[3] While a percentage decrease over

1 The Division of Rural Surveys of the Reserve Bank of India observed on the basis of data on the sources of finance that internal financing or "own funds" was important for both participants and non-participants in the Higher-Yielding Varieties Programme. However, it is not known whether these funds are the fruits of saving, the sale of assets or borrowings from other sources. To the extent that participants are large farmers, it could be inferred that own funds relate to this category of farmers; Report of the All-India Rural Credit Review Committee, _op.cit._, p 24. _Report of the Higher-Yielding Varieties Programme_, _op.cit._, pp 31, 43-44.

2 Mukherjee, P.K. 'Higher-Yielding Varieties Programme - the Variables that Matter,' _op.cit._, p A22.

3 George, P.S. and Choukidar, V.V. _Production and Marketing Pattern of Paddy_, _op.cit._, p 29.

a few years, still less, over a couple of years is no adequate proof that surplus funds in the hands of large farmers have not found their way into cooperatives, there is indirect evidence to show that increases in deposits are not significant. The Reserve Bank of India observed that, except in Punjab, credit societies have not been able to mobilise increased surplus generated in the rural areas since the introduction of HYV.[1] This could, of course, be a reflection of low interest rates on deposits so that in order to attract rural savings, cooperatives would have to raise deposit rates. But as Ghatak argues the net result of increasing deposit rates would be to raise lending rates and thereby choking-off the supply of credit to small farmers even further.[2]

Another possible indication of the spread of the activities of agriculturist moneylender is mounting overdues. Overdues as a percentage of Central Cooperative Banks increased from 26 per cent to 34.2 per cent over the period 1968-70 and that Primary Credit Societies increased from 33 per cent to 43 per cent between 1967-68 and 1969-70.[3] Part of the overdues may be regarded as wilful defaults because a study made by the Programme Evaluation Organisation showed that overdues were not peculiar to small farms and the percentage of overdues to loans outstanding was significantly higher on large farms than on small farms.[4] In Andhra Pradesh the percentage of overdues to total loans made by cooperatives was found to be an increasing function of size.[5]

1 Progress of the Cooperative Movement in India, op.cit., p 72.

2 Ghatak,S. Rural Money Markets in India, op.cit., p 180.

3 Progress of the Cooperative Movement in India, op.cit., pp 61 & 77.

4 On large farms overdues as percentage of loans outstanding was as high as 30 to 46 per cent, Government of India, Planning Commission, Programme Evaluation Organisation. Evaluation Report on the Working of Large and Small-Sized Cooperative Societies, New Delhi, 1959, pp 52-56; see also Apte,S.G. 'Cooperative Agricultural Credit - Some Disquieting Trends,' Indian Journal of Agricultural Economics, XXVI, 4, Oct.-Dec. 1971, pp 451-457.

5 Parthasarathy,G. Green Revolution and the Weaker Section, op.cit., p 37.

Although we have only indirect evidence on the extent of the credit operations by agriculturist moneylenders, still less the extent to which their access to cooperative credit at low rates of interest enables them to substitute the latter for their own savings, their role in the rural money market is significant. In a study of the regional distribution of credit it has been observed that "if commercial banks have strengthened the hands of the private industrial financiers, cooperative credit societies have strengthened the hands of the agricultural moneylender."[1] The reasons for their continuing strength are the prevailing high rates of interest in the unorganised money market, the fact that they give loans for consumption and their less bureaucratic form of administration compared to cooperative societies.[2] What is more, their ability to supervise credit eliminates the need to impose burdensome requirements of security. Thus, despite the lower rates of interest charged by cooperative societies (Table V.12) compared to agriculturist moneylenders who charge between 18 and 25 per cent per annum, small farmers continue to depend upon the latter because of the importance of the consumption element in their borrowing.[3] Loans for consumption purposes amounted to only 1 per cent of total loans given by Primary Agricultural Credit Societies in Andhra Pradesh.[4]

1 Pai,A.G. 'Regional Distribution of Bank Credit - A Critical Review,' EPW, V, 41, Oct. 1970, p 1699. The resistance to the amalgamation of weak cooperative societies in a bid to make them viable in Andhra Pradesh has come largely from this category of farmers, Parthasarathy,G. Green Revolution and the Weaker Section , op.cit., p 38.

2 Their loan procedures are very simple, often made on the spot. In the 1950's moneylenders accounted for 84 per cent of loans taken for non-productive purposes, 33 per cent of which was for consumption, NSS, Tables with Notes on Rural Indebtedness, op.cit., p 8.

3 RAIRCRC, op.cit., p 691; rates as high as 36 per cent per annum are not uncommon, ibid. Parthasarathy,G. Agricultural Development and Small Farmers, A Study of Andhra Pradesh, op.cit., pp 79-87.

4 Statistical Statements Relating to the Cooperative Movement in India, 1970-71, Part I, op.cit., p 101.

Table V.12. Interest Rates Charged to Individuals - Short Term Advances

Andhra Pradesh - 1970-71

(in per cent per annum)

Type of Bank/Society	Interest Rate	
State Cooperative Bank	8	
Central Cooperative Bank	8	(Range $3-7\frac{1}{2}$)
Primary Cooperative Society	$9\frac{3}{4}$	(Range $7\frac{1}{2}-12$)
Small-Sized Agricultural Credit Society	$9\frac{3}{4}$	(Range $7\frac{1}{2}-15$)
Large-Sized Agricultural Credit Society	$9\frac{3}{4}$	(Range $8\frac{1}{2}-15$)

Source: Statistical Statements Relating to the Cooperative Movement in India, 1970-71, op.cit., pp 155, 158, 159.

To determine the nature of dependence on cooperative societies and agriculturist moneylenders the ideal thing to do would be to calculate the interest elasticity of demand for credit.[1] Here again, want of sufficient data on actual amounts borrowed at different rates of interest by large farmers and small farmers is the chief deterrent. A review of estimates made by researchers on the subject shows that there is no firm evidence regarding interest elasticity of demand for credit.[2]

1 A vital consideration here is the determination of average rate of interest in the rural money markets. This is a problem by itself and has been attempted by Ghatak. On the basis of his calculations he concludes that rural interest rates are not as high as it is commonly supposed, the average rate in the 1950's and 1960's being in the range 14-17 per cent, Ghatak, S. Rural Money Markets in India, op.cit., Chapter IV, pp 106-160.

2 For a summary of estimates made in this connection see Lele, Role of Credit and Marketing Function in Agricultural Development, op.cit., p 10. Where differences exist between the debt-carrying capacities of small and large farms, interest-elasticity will be greater for small farmers than large farmers, see Desai, B.M. & Desai, D.K. 'Is Inadequacy of Institutional Credit a Problem in Changing Agriculture?' Economic and Political Weekly, V, 39, Sept. 1970, pp A101-110.

In this discussion of the role of the agriculturist moneylender we have been able to indicate the reasons for his importance in the supply of credit. Lack of data on the actual amounts borrowed by farmers from this source has prevented us from quantifying his role except in global terms. Although our conclusions here are a bit vague, to ignore the presence of agriculturist moneylenders would be to exclude a large sector not only in the non-organised sector of the rural money market but in both sectors organised and non-organised. Assuming, therefore, that agriculturist moneylenders provided credit to small farmers we can now match the demand for credit and the actual supply of credit by the cooperative societies. This is done in Table V.13. In section V.2 we gave three estimates of credit requirements, Table V.2. Columns 5 to 7 in Table V.13 give the magnitude and signs of difference between the estimated credit requirements and the actual amounts supplied. The actual amount supplied to the two smallest farm sizes in both seasons was wholly inadequate to finance the cultivation of the new varieties. Column 6 bears out our hypothesis that cooperative credit flowed to farmers who possessed assets as shown by the positive signs for farms above 10.00 acres in size in both seasons. The assumption made in calculating credit requirements in this case was that farmers financed part of the expenditure on the new varieties from own resources. Taking into account consumption needs, as we do in the third estimate of demand, we find that, in general cooperative credit was inadequate to meet the needs of farms below 15 acres in size in both seasons.

Table V.13. Estimates of Demand for and Actual Supply of Credit, West Godavary, 1968-69

Rupees

Farm Size (acres)	Estimates of Credit Requirement Estimate I	Estimate II	Estimate III	Amount Actually Supplied	Sign and Magnitude of Difference (4-1)	(4-2)	(4-3)
1	2	3	4	5	6	7	8
Kharif							
Below 5.00	6245.68	3240.96	12430.31	3115.00	- 3130.68	- 125.96	- 9315.31
5.01 - 10.00	14559.76	5201.25	12139.08	2040.00	-12519.76	-3161.25	-10099.08
10.01 - 15.00	9099.17	1066.06	7108.26	3600.00	-5499.17	+2533.94	- 3508.26
15.01 - 20.00	3154.22	2090.19	4886.57	2100.00	- 1054.22	+ 9.81	- 2786.57
20.01 & Above	76207.42	15507.32	17443.63	34700.00	-41507.42	+1992.68	+17256.37
Rabi							
Below 5.00	10360.88	5585.15	7950.07	90.00	-10270.88	-5495.15	- 7860.07
5.01 - 10.00	11132.11	6188.66	6188.66	1000.00	-10132.11	-5188.16	- 5188.16
10.01 - 15.00	7361.79	2547.00	2946.00	2935.00	- 4426.79	+ 388.00	- 11.00
15.01 - 20.00	8500.25	863.00	863.00	1500.00	- 7000.25	+ 637.00	+ 637.00
20.01 & Above	10840.70	96.71	1606.78	500.00	-10340.70	+ 403.29	- 1106.78

Source: Appendix Tables VII; Report for Kharif, Appendix Table 46 and Report for Rabi, Appendix Table 34.

In Section V.3 and V.4 we tried to show how the security-based lending policies of cooperative societies lead to unequal distribution of credit and dependence of small farmers on agricultural moneylenders. If the distribution of farm sizes and assets were not so skewed, security-based lending would be desirable as it imparts a degree of certainty in the supply of credit.[1] As an alternative to security-based lending, the All-India Rural Credit Review Committee recommended the adoption of the Crop Loan System. The details of this system are described in the next section. We hope to show that even this scheme is unlikely to benefit the small farmer.

1 See Dantwala,M.L. 'Institutional Credit in Subsistence Agriculture,' Artha-Vikas, III, 2, July 1967, pp 1-11; for a more rigorous explanation see Baker, C.B. 'Credit in the Production Organisation of the Farm,' American Journal of Agricultural Economics, V, 3, August 1968, pp 509-510.

V.5. The Crop Loan System

The Crop Loan System was evolved in order to enable cooperative credit to reach a wider section of farmers. It marked a change from security-based lending to credit based on repayment capacity.[1] The chief characteristic of the system is the "scale of finance" per acre granted for the cultivation of different kinds of crop. It consists of three elements. (a) A cash loan for the cultivation of traditional varieties. The loan is not to exceed one half of the value of total gross produce. (b) A kind component equal to the cost of new inputs like fertilisers and pesticides and (c) a cash loan equivalent to half the value drawn under (b). This is to enable farmers to meet the incidental charges that have to be paid in the use of new inputs. The total scale of finance for West Godavary for paddy is Rs 300, being made up of Rs 150 (a), Rs 100(b) and Rs 50(c).[2]

According to this system, loans for production are given on the basis of estimated outlays on the crop. The emphasis is on the disbursement of loans in kind as far as possible.[3] The repayment capacity of the borrower is linked to the production potential of the loan. Recoveries are made at the time of the harvest. The repayment capacity of the borrower for short term loans is set at one-third the value of gross produce.[4]

1 The system is not entirely new. It was first recommended by the All-India Rural Survey, op.cit., Vol. II, Part I, p 386. The Rural Credit Review Committee elaborated the scheme and made recommendations for expanding crop loan credit. The procedures for extending credit to support intensive agricultural programmes are laid down in the Crop Loan Manual, All-India Rural Credit Review Committee, pp 31 & 32.

2 George,P.S. & Choukidar,V.V. Production and Marketing Pattern of Paddy, op.cit., pp 28 & 247; for the working of the Crop Loan System in Andhra Pradesh see also Report of the All-India Rural Credit Review Committee, op.cit., pp 204-206. The scale of finance is finalised on the basis of the recommendations made at annual conferences convened by the Central Cooperative Banks consisting of representatives of Cooperative Societies and field workers, ibid., p 32.

3 At present the entire amount of the loan is made in the form of cash in West Godavary, Production & Marketing Pattern of Paddy, op.cit., p 29.

4 Report of the All-India Rural Credit Review Committee, op.cit., p 467.

Despite the concerted efforts of the Reserve Bank and the Cooperative Societies, progress in the implementation of the Crop Loan system has been unsatisfactory.[1] It relies on an aggregative yardstick of credit requirements for a crop, rather than for an individual cultivator.[2] The norm means nothing if the individual's borrowing power remains unchanged. The shift in emphasis to production potential is a subtle one - the shift from the credit-worthy farmer to the credit-worthy use of the loan. The lending policy of the co-operative continues to be based on the banking principle.

The implementation of other aspects of the System has also come up against difficulties. The distribution of the kind components has been hindered by supply and distribution bottlenecks.[3] A measure adopted to ensure repayment is the seasonality of lending and borrowing, but here again it has not been possible to adhere to the system closely because of practical difficulties. Farmers are used to borrowing when they like and to repaying at the end of the cooperative year.[4] Finally, the success of the system depends upon a degree of supervision, and this is totally beyond the capabilities of the extension agencies as they exist now. From a comparison study of the Crop Loan System in Andhra Pradesh, Chaudhuri and Sharma found that even as late as

1 Report of the All-India Rural Credit Review Committee, op.cit., p 175.

2 Desai,B.M. & Desai,D.K. 'Is Inadequacy of Institutional Credit a Problem in Changing Agriculture,' Economic and Political Weekly, op.cit., p A101.

3 For problems associated with the distribution of fertilisers in kind see Chapter III.

4 For a detailed study of the operational difficulties attending the Crop Loan System, see Chauhan,D.S. 'Popularity of the Cooperative Movement,' Indian Cooperative Review, V, 1, Oct. 1967, pp 60-62; see also Parthasarathy,G. Agricultural Development and Small Farmers - A Study of Andhra Pradesh, op.cit., p 83.

1970 no concerted action to introduce the system in Andhra Pradesh had taken place, unlike Punjab.[1]

The difficulties associated with the Crop Loan System cannot be regarded as being operational ones in the sense that they can be expected to disappear once problems of administration have been sorted out. The rationale of the system is that the grant of credit on the basis of production potential is self-financing. As Dantwala has observed, credit is self-financing only in a technical sense.[2] Ultimately it depends upon the size of surplus production. Small farmers will continue to experience difficulties in getting credit even under this system because consumption requirement will be the first charge on total production.[3] The lack of provision for consumption credit undermines the effectiveness of this system so far as small farmers are concerned. To be effective, repayment capacity has to be re-defined.

1 Chaudhuri,T.P.S. & Sharma,J.N. The Crop Loan System - A Study of Andhra Pradesh and Punjab, National Institute of Community Development, Hyderabad, 1970, reviewed by Bapat,B.K. in Indian Journal of Agriculture, XXVI, 4, Oct.-Dec. 1971, pp 255-256.

2 Dantwala,M.L. 'Institutional Credit in Subsistence Agriculture,' op.cit., pp 1-11.

3 Although the Programme Evaluation Organisation noted the importance of consumption expenditure in measuring repayment capacity, in its reports it excluded this item while estimating total expenditure of farms cultivating the new varieties, see Report on the Evaluation of High-Yielding Varieties Programme, Kharif 1968, op.cit., p 56. We have already noted the importance of consumption expenditure, judging by the predominance of cash loans taken, refer Section V.I. According to the National Sample Survey, 18th Round, expenditure on food constituted 45 per cent of total expenditure in rural areas. Using the results of the NSS Sinha found the rural expenditure elasticity to be 0.66, see Sinha,R.P. 'An Analysis of Food Expenditure in India,' Journal of Farm Economics, XL, 1, Feb. 1966, p 120. The importance of consumption expenditure can also be gathered from the magnitude of the diversion of loans taken from cooperatives to consumption purposes. Nearly 40 per cent of short term loans taken by farmers possessing less than 5 acres was diverted to other uses. The proportions were 25 per cent to 28 per cent and 5 per cent to 12 per cent in the farm size groups ranging from 10 to 30 acres and 30 to 60 acres respectively. Study of the Utilisation of Cooperative Loans, op.cit., p 97; see also, Jakhade, V.M. 'Small Farmers and Cooperative Credit,' in Indian Society of Agricultural Economics, Seminar Series, Seminar on the Problems of Small Farmers, Bombay 1967, pp 82-97.

Repayment capacity must be determined in relation to the farm family as a whole, i.e. the amount of income that will be available for repayment of loans taken will have to be determined by the income and consumption of the family and its pre-existing liabilities. Repayment capacity (R) may be defined as the excess of a borrower's total estimated income (Y) over the sum of consumer expenditure (C), repayment due to pre-existing liabilities and a margin (K) to care of increased liabilities during the year.
repayment capacity is given by the equation:

$$R = Y - (C + L + K)$$

where the letters stand for estimated annual values of the respective parameters.[1] In using this equation two assumptions are made. First, the additional income expected from the investment in new inputs can be set aside for the repayment of loans. Second, farmers can stabilise their consumption levels at levels permitted by the pre-investment income (i.e. income earned before the use of new inputs. The validity of these two assumptions depends upon the level of consumption expenditure in relation to pre-investment income. There are two possibilities here.

1 Our analysis of repayment capacity is on the lines suggested by M/s Jakhade and Gadgil of the Division of Rural Surveys, Economics Department, Reserve Bank of India. Although their study refers to medium term loans for investment in the construction of wells, installations of pumps and in tractors, their analysis can apply equally to short-term loans. Their study elaborates the idea that to make cooperative finance effective in schemes for increasing production, the basis oflending must be the economic feasibility of the proposed investment. Loans will then be both self-liquidating and income-generating. Jakhade,V.M. & Gadgil,M.V. 'Production and Repayment-Orientated Lending for Farm Investment,' Reserve Bank of India Bulletin, XXXIV, 1, Jan. 1970, pp 56-77. The reader will recall that in our analysis of the economic feasibility of wells and tubewells we followed a similar technique.

If the pre-investment consumption is adequate to satisfy the family's "minimum need-based living" standard, it is unlikely to divert a substantial part of the additional increased income for consumption purposes. If the family is living at a semi-starvation level during the pre-investment period, it is unlikely to divert a large proportion of the additional income for the satisfaction of basic wants. Only in the first case is the farmer able to regulate his increased consumption without jeopardising the repayment of the loan. Therefore, repayment capacity will depend upon the effect increased income will have on increased consumption. For farmers who live at the subsistence level, this ability is nil. In terms of our equation, the value of Y will be swamped by the values of C, L and K taken together. Given the high marginal propensity to consume and high proportion of debt outstanding, repayment capacity of small farmers will be nil. From this it follows that additional income from investment in new seeds cannot be set aside to repay loans.

In the absence of data for deriving estimated annual values of Y, C, L and K we have to make do with an alternative measure of repayment capacity. This is the rate of return from the cultivation of HYV.[1] A comparison of rates of return across farm sizes, though not a perfect substitute for the formula used so far, is however, an adequate one under the circumstances. Retaining the two assumptions we made on p 260 , negative rate of return can be taken to mean negative repayment capacity. Table V.14 shows the rates of return on our sample farms.

1 The rate of return is defined as the ratio of additional net value added to additional working capital. The method adopted here is borrowed from Schulter,M.G.G. The Role of Cooperative Credit in Small Farmer Adoption of the New Cereal Varieties in India, Occasional Paper 64, Employment and Income Distribution Project, Department of Agricultural Economics, Cornell University, May 1973, p 22.

Table V.14. Rate of Return on Sample Farms, West Godavary, 1968-69

Rs/acre

Farm Size (acres)	Total Expenditure HYVP	Total Expenditure TRAD	Net Value Added HYVP	Net Value Added TRAD	Additional Working Capital Requirement of HYV	Additional Net Value Added	Rate of Return (%)
1	2	3	4	5	6 (2-3)	7 (4-5)	8 (7/6)
Kharif							
Below 5.00	406.62	253.14	715.85	1395.15	153.48	- 779.30	- 507
5.01 - 10.00	349.91	224.35	119.78	675.54	125.56	- 555.76	- 442
10.01 - 15.00	419.51	235.53	824.15	64.31	183.98	759.84	+ 413
15.01 - 20.00	303.29	241.48	731.03	111.73	61.81	619.30	+ 1001
20.01 & Above	405.92	226.94	497.95	-178.49	178.98	+ 676.44	+ 377
Rabi							
Below 5.00	477.46	366.97	549.55	29020.15	110.49	-28470.60	-25767
5.01 - 10.00	548.38	431.68	471.72	3973.40	116.70	- 3501.68	- 3000
10.01 - 15.00	561.54	452.65	960.20	774.59	108.89	185.61	+ 170
15.01 - 20.00	680.02	449.84	328.65	1654.41	230.18	- 1325.76	- 576
20.01 & Above	626.63	458.54	687.99	1971.26	168.09	- 1283.27	- 763

Source: Appendix Tables VII and IX.

A comparison of rates of return shows that farms in the smallest size-classes are characterised by negative returns. This can be attributed to non-optimal combination of inputs required for the cultivation of HYV. Table V.14 also shows that the net value added from the cultivation of these varieties on these farms is lower than that from the cultivation of traditional varieties.

The upshot of all this is that the search for the basis of lending that will enable the provision of credit to as wide a section of the farming population as possible will be fruitless so long as the credit needs of small farmers are not diagnosed basically as an income problem and the lending policy of credit institutions modified suitably. We are not interested in repayment-capacity per se. The importance of consumer expenditure has to be recognised in an operational sense in the calculation of credit needs by institutional lending agencies. Assumptions about consumer expenditure are not good enough. What is required is the determination of the likely magnitude for different family sizes in different size-group of farms. Formal models of agricultural development are not of much use here because they are based on the all too naive assumption that the elasticity of consumption with respect to productivity per unit of labour is institutionally determined.[1] So long as factors making for the initial conditions of low income are not removed, given the high consumption propensities of small farmers, they will not be able to make an impact on increased production.

1 Ishikawa, S. Economic Development in Asian Perspective, op.cit., p 53 and p 33.

Conclusion

The general objective of this chapter was to show that small farms can make an impact on rice production if credit is made available to them. We set about proving this by looking at the determinants of demand for credit and the chief sources of supply of institutional and non-institutional credit. Demand for short-term credit for the cultivation of traditional varieties on small farms arises largely due to low incomes and negative savings. With the introduction of HYV the demand for production credit is superimposed on their demand for consumption loans. On large farms, credit is needed largely to finance purchase of new inputs although in the case of agriculturist money-lenders, a part of loans taken from cooperatives is re-lent to other farmers.

Estimates of credit requirements were calculated by us on the basis of actual working capital requirements which were in turn based on actual levels of expenditure incurred by farmers in West Godavary. Three different estimates were made on the basis of three assumptions. In the first case it was assumed that the entire expenditure on new inputs is financed by credit. In the second case we assumed that part of the expenditure on new inputs is met from own resources and thirdly it was assumed that in addition to credit for production, consumption loans will have to be made. Using regression analysis we established that working capital requirements for the cultivation of new varieties are the same for both large farms and small farms. The inference here is that given comparable opportunities to acquire the new inputs, productivity on small farms even in the cultivation of new varieties will not be different from that on large farms.

Matching total demand for credit with actual supply of cooperative credit, we found that cooperative credit fell short of requirements of farms below 10 acres in size. We traced the general inadequacy of the supply of cooperative credit to the lending policy of cooperative societies. We found a positive correlation between farm size and level of assets. Cooperative lending being based on the security of assets, cooperative loans flowed predominantly to large farms. We found that small farms are disqualified not only because of the low levels of assets they possess but also because of their status as tenants which makes them poor lending risks. Although legislation exists for providing credit to farmers who cannot show title to land or some other immovable property, it is observed in breach and small farms continue to be disenfranchised in this respect. Disqualified from acquiring loans from cooperatives, small farmers turn to agricultural moneylenders who are the next best source, their added attraction being that they give loans for consumption purposes. The role of the agriculturist moneylender, although ubiquitous is difficult to quantify. The tenurial disincentives faced by small farmers is, to a large degree, caused by the chameleon characteristics of the agriculturist moneylender who is farmer, trader, moneylender, surety and landlord all rolled into an engine of exploitation. In order to reduce the influence of non-institutional credit and to enable small farmers to acquire cooperative credit, the Reserve Bank of India, as part of its intervention on the agricultural credit scene, introduced the Crop Loan System. This system marked a change from security-based lending to lending based on repayment capacity as determined by the production potential of the loan. We argued that as this new system does not make any provision for consumption credit, owing to the importance of the latter on small farms, this system is not likely to catch on with small farmers. The success of the Crop Loan System depends very much upon the recognition that on small farms, consumption needs are the first claim on increases in income. We can begin to talk about production potential of loans only when income deficits have first been corrected. As the production potential of small farms is acknowledged, a case can be made for discrimination in favour of them in the provision of new inputs in the form of credit. And this is the burden of our argument in this chapter.

CHAPTER SIX

CONCLUSION

High-yielding varieties of rice have yet to make an impact on rice production in India. The thesis has attempted to show that this is due to the non-fulfillment of certain preconditions and to the predominance of small farms in rice cultivation.

The first precondition for the successful cultivation of the new varieties is controlled irrigation. We argued how the existing system of canal irrigation in Andhra Pradesh is wholly inadequate to support their cultivation. We also found that on account of both geographical factors and the limited resources available for investment in them, private tube-wells are not the ideal means of irrigation to support the cultivation of new varieties in this state. Electrified wells appear to offer the best advantages.

The second precondition for the successful cultivation of the new varieties is the availability of cheap fertilisers. Fertiliser production in India at present is insufficient to promote extensive cultivation of these varieties. We argued therefore that rationalisation of the fertiliser industry of India is essential and that the distribution and marketing problems associated with this input can only be solved by increasing the supply of cheap fertilisers.

The non-fulfillment of the preconditions has meant that not only has the yield potential of the new not been realised but its capacity for giving fuller employment on farms has also not been fully exploited. We saw how the cultivation of higher-yielding varieties increases labour requirement on farms. Labour is a critical input at certain periods in the growth cycle of the rice crop, critical enough to jeopardise their high-yielding ability. The importance of the labour input led us to believe that the new varieties of rice will create more employment on farms in the short run. We would go so far as to say that this tendency will persist in the long run because we discount the possibility of mechanisation in rice cultivation. This we do on two grounds. Firstly, the development of machinery for wet cultivation is still in its early stages and their widespread use is a remote possibility. Secondly, owing to their extreme fragmentation, conversion of rice fields into compact blocks to enable mechanisation calls for radical institutional re-organisation which is also regarded as unlikely to materialise in the future.

Little progress has been made in the cultivation of new seeds because of their varietal characteristics. The rice plant is less amenable to genetic engineering than other cereals. The varieties introduced so far have yet to develop into hardy strains.

The other factor identified in the thesis as contributing to slow progress in production of the new varieties is the socio-economic handicap faced by small farmers. The disincentives they face on account of small size of farms and tenurial arrangements like crop-sharing are reflected in their inferior access to institutional credit. Small farmers and large farmers have unequal opportunities to acquire new inputs; because of this it is not possible to capitalise on the higher production potential on small farms. Central to our argument is the inverse relation between yield per acre and farm size. Given the physical characteristics of the new varieties, the divisibility of most of the supporting inputs, the deployment of labour on small farms and the labour-intensive nature of cultivation of higher-yielding varieties of rice, we feel that positive discrimination in favour of small farmers in the supply of inputs will not only make them more economically viable but will enable them to increase their contribution to total rice production in the country.

The introduction of higher-yielding varieties has led to growing complexity of rice production. Correspondingly, the infrastructure and the socio-economic institutions necessary to support it grows in complexity. The need arises therefore for radical and imaginative changes in organisation, for, the potential benefits of technical change derive from its interaction with the institutional structure of agriculture. Thus we argued that small farmers should be subsidised by credit to enable them to take advantage of technical change and to contribute effectively to the programme for increasing the production of foodgrains.

APPENDIX I

Definition of Labour Input

As cultivation of crops is the primary occupation of both family and hired labour on our sample farms, the analysis of the employment pattern requires a definition of labour input. Labour input in agriculture can be measured either by the participation rate, that is the proportion of the total labour force normally performing some work during the year, or in terms of the duration of work done by labourers in terms of man-days per year.[1] Both these measures present difficulties. Attempts to define labour input in agriculture has not attracted as much attention or glamour as the definition of capital in industry has done.[2] Much of the difficulty arises because climatic and physical factors like the growing habit of crops thwarts attempts to derive a standard or norms in terms of duration of work that reflects a uniform intensity of effort.[3] Nevertheless attempts have been made to define labour input with varying success, and these are discussed briefly in the following paragraphs.

1 The former method has been adopted by the National Sample Survey and the latter by the Farm Management Surveys.

2 See Joan Robinson's complaint about "fuzzy nature of the capital variable in the aggregate production function," in Harcourt,G.C. 'Some Cambridge Controversies in the Theory of Capital,' Journal of Economic Literature, VII, 2, June 1969, p 370.

3 This is not to suggest that the industrial norm of an eight-hour day signifies an uniform intensity of effort.

The first attempt to measure the basic labour unit in terms of "the day" was made by the Second Agricultural Labour Enquiry.[1] In the First Agricultural Labour Enquiry, the number of hours worked and the intensity of effort were not indicated at all, but we gather from the second enquiry that wage employment of half a day or more was counted as a full days' work.[2] In the Second Enquiry, the standard length of the working day was taken to be ten hours. Distinctions were made between different intensities of effort, full, half, nominal and nil.[3] But these are merely conventions used for the purpose of the enquiries mentioned and cannot be employed as universal norms.

A standard for measuring labour input can also be found in the National Sample Survey which did a comprehensive geographic coverage of labour inputs in rice cultivation.[4] Labour input, both family and hired labourers employed per day are given irrespective of the number of hours worked. However a norm in terms of the number of hours worked can be obtained from the definition of "Full-employment," in another report of the NSS. The modal value of the distribution of gainfully employed labour in terms of hours lies in the range of 43-46 hours a week, and this works out to be 6½ hours a day, roughly.[5]

1 The Second Agricultural Labour Enquiry, op.cit., p 65.

2 Ibid.

3 Ibid., pp 66-67. Wage employment refers to both agricultural and non-agricultural work.

4 National Sample Survey, V-VII Rounds, 1951-52 & 1952-53, Some Aspects of the Cost of Cultivation of Paddy, Wheat, Jowar and Bajra, No. 32, Part 1, pp 22-28. It is only in this report that we are given a measure of labour input in terms of hours worked. In all the other NSS reports on employment measurement is in terms of participation rates.

5 NSS, Round IX (Preliminary) May-Nov. 1955, Report on Employment and Unemployment, No. 16, pp 40-41. For the nature of employment intensity in rural areas see p 38.

The basic unit in the definition of labour input used in the Farm Management Surveys which is the one adopted in deriving our estimates of labour requirements is an eight-hour day. Here, the quantum of visibly employed labour applied to crop production and its distribution among different agricultural operations is described in terms of "labour-time-disposition."[1] The concept refers to man-hours per day per acre. Full employment refers to the performance of work in a eight-hour day for 365 days.[2]

1 An example of the use of this concept in measuring manpower applied annually in Indian Agriculture during 1947-49 to 1961-62 can be found in John, P.V. Some Aspects of the Structure of the Indian Agricultural Economy, 1947-48 to 1961-62, Institute of Economic Growth, Asia Publishing House, 1968, pp 118-134.

2 Farm Management Survey, West Godavary (Andhra Pradesh) op.cit., pp 82-97.

APPENDIX II

Sources of Data

All data used in the thesis are taken from official sources. The principal sources are listed below along with brief descriptions of their sampling frames. One of the greatest problems encountered in our study was the lack of continuity of statistical series for the state and districts over time. The statistical framework of the thesis as a whole is based on the data given in the reports on the HYVP for Kharif and Rabi, 1968-69, which were compiled by the Agro-Economic Research Centre, Andhra University. The reports give information for both the West Godavary district and the East Godavary district. In the analysis of the economic aspects of HYV and the description of our results we confine our attention to the former district alone. Observations for East Godavary district are included, however, in the derivation of regression coefficients in the course of our statistical analysis.[1] These reports provide information on farms cultivating HYV and traditional varieties. These farms are referred to as "our sample farms" throughout our study.

Information on the input and output structures of farms cultivating rice in the pre-HYV era was obtained from Studies in the Economics of Farm Management, West Godavary, Andhra Pradesh. Where possible, detailed statistical tests were carried out using the data given here in order to reinforce our ideas about production relationships in the cultivation of

1 When fitting regression equations we have simply pooled the data for the two districts for two seasons. No attempt was made to include dummy variables as preliminary results showed that regression coefficients for dummy variables were statistically insignificant.

traditional varieties. This source has also provided us with an understanding of the cultural practices in the cultivation of paddy in West Godavary. Finally, reports of the Programme Evaluation Commission have been used to check for consistency where possible. Brief details of these principal sources are given below.

<u>Report on the Study of HYVP (Kharif 1968-69, Phase II) and Report on the HYVP (Rabi 1968-69)</u>[1]

These reports were preceded by a preliminary report issued in November 1968, which gives details of the administrative aspects of the programme.[2] The sampling design which forms the basis of the Kharif report is as follows: in each district two community development blocks and from each block two villages were selected according to the criterion that each village should have 20 farmers cultivating IR-8. Two groups of cultivators were selected, participants and non-participants, and each group was divided into five classes depending upon the size of their operational holdings. The total number of farmers in each group was selected randomly in proportion to the population in each size class such that for each village there were 15 participants and 10 non-participants. For the district as a whole there were thus 60 participants and 40 non-participants.[3]

1 Agro-economic Research Centre, Andhra University, <u>Report on the Study of High-Yielding Varieties Programme (Kharif, 1968-69, Phase II)</u> and <u>Report on the Study of High-Yielding Varieties Programme (Rabi 1968-69)</u>; Waltair, September 1969 and December 1969.

2 Agro-economic Research Centre, Andhra University, <u>Preliminary Report on the Study of High-Yielding Varieties Programme</u>, (Kharif 1968-69, Phase I)

3 <u>Report for Kharif</u>, <u>op.cit.</u>, p 1; see Appendix Tables V & VI for the distribution of farmers according to size distribution of farms.

In the design of the study for Rabi, two villages were selected according to the criterion that there were at least 10 participants raising any high-yielding variety of rice. In each village participants and non-participants were classified into 5 groups according to the size of operational holdings. A random selection of participants was made according to probability proportional to population in each size class. In each village the sample consisted of 15 participants and 10 non-participants, the total number for each category for the district being 30 and 20 respectively.[1]

Studies in the Economics of Farm Management, West Godavary (Andhra Pradesh) 1957-58, 1958-59 and 1959-60.[2]

The Farm Management Surveys for Andhra Pradesh belongs to the second category of such surveys made for the whole of India.[3] The Farm Management Survey[4] is based on the cost accounting method. It divides the district into the paddy zone and the tobacco zone. For the study of resource use in paddy cultivation seven villages in the paddy zone were selected on the basis of random sampling with probability proportional to the cultivating population as given in the District Census Handbook 1951.[5]

1 Report for Rabi, op.cit., pp 1 & 2

2 These are published by the Directorate of Economics and Statistics, Ministry of Food, Agriculture, Community Development and Cooperation, Government of India. The dates of actual publication of the three reports mentioned above are 1966, 1965 and 1968. The publication of the results of the survey for 1958-59 preceded that of 1957-58 and this is an example of the much lamented phenomenon - delays in the publication of official statistics.

3 Refer p 38 above for a description of the Farm Management Surveys in general.

4 These surveys are henceforth referred to as FMS (date)

5 FMS, 1957-58, op.cit., p 10.

Although we shall have occasion to dip into several of the evaluation reports of the Programme Evaluation Commission, we shall outline the chief characteristics of the principal report used by us, namely, Report on Evaluation of High-Yielding Varieties Programme, Kharif 1968.[1] These reports are a legacy from the ones started in the Rabi season of 1965-66 which had the object of appraising the emergency food production drive.[2] They were in the nature of quick observational studies focussing principally on the planning, programming and implementing of agricultural development programmes. Since the start of the HYVP at the instigation of the Planning Commission, the Programme Evaluation Organisation undertook to study the implementation of the new agricultural strategy. Investigations are usually based on field studies carried out in community development blocks representing principal crops. The representation of blocks and crops varies from report to report. The Kharif study refers to a sample of 44 Blocks distributed all over the country representing various crops included in HYVP. A two stage method of sampling was followed with the district at the first stage and the block at the second stage. The selection of districts was made on the basis of probability proportional to the area targetted for the different crops in the different states. A sample of three villages was selected from each sample block, once again, according to probability proportional to the target for the area under the relevant HYV crop. For each

1 Government of India, Planning Commission, Programme Evaluation Organisation, Evaluation Study of the High Yielding Varieties Programme, Report for Rabi 1967-68 (Wheat, Paddy & Jowar), 1968; the same for Rabi 1968-69 (Wheat, Paddy & Jowar), 1969; the same for Kharif, 1967, 1968; Report on Evaluation of the High Yielding Varieties Programme, Kharif 1968, 1969.

2 Evaluation Study of the High Yielding Varieties Programme, Report for Kharif, op.cit., p 1.

village a list of cultivator-households participating in the HYVP was drawn up according to the size of holdings and from this list a sample of ten households was drawn up by the method of systematic sampling with equal probability.[1]

Finally, we come to one of the perennial questions: the reliability of the statistics in the above sources. References to the lack of precise and reliable statistics in India in common with other so-called less-developed countries are legion. The partial listing of inadequacies in Myrdal's Asian Drama is only the tip of the ice-berg.[2] Ely, in his criticism of Myrdal's gloom and despondency about the matter, draws attention to the general improvement in statistical methodology and the use of sampling techniques in the compilation of statistical data in India and elsewhere, in recent times.[3] The fact that the sources mentioned above use sampling frames is a step in the direction of precision and reliability, however small. The best that we can hope for when using secondary sources of information is some kind of internal consistency, which at the simplest level may amount to only arithmetical accuracy. Ultimately, the employment of statistical data in empirical research is an act of faith! The widespread use of statistical series by interested and disinterested persons gives them a certain degree of credence![4]

1 Report on Evaluation of High-Yielding Varieties Programme, Kharif, 1968, op.cit., pp 67-69.

2 Myrdal, G. Asian Drama, An Enquiry into the Poverty of Nations, Vols. I to III, Penguin Books, 1968, p 481.

3 Ely, J.E. 'Some Comments on the Treatment of the Problems of Inadequate Statistics of South Asian Countries in Asian Drama by Gunnar Myrdal,' Journal of Economic Literature, VIII, 1, March 1970, pp 46-52.

4 There is a certain inconsistency verging sometimes on paranoia about the importance some people attach to the reliability of statistics in under-developed countries. We were led to reflect on this by an observation made by Mr. A.M. Khusro at a seminar at the School of Oriental & African Studies some years ago. The gist of it was that reference to any positive phenomenon (say doubling of grain harvest) is received with scepticism whereas the mention of any negative phenomenon (say, rodents destroy 50 per cent of harvest) is believed!

APPENDIX TABLE I

State-Wise Compound Growth Rates of Area, Production and Productivity for Rice 1952-53 to 1964-65 and 1964-65 to 1970-71

State	Percentages 1952-53 to 1964-65			Percentages 1964-65 to 1970-71		
	Area	Production	Productivity	Area	Production	Productivity
1	2	3	4	5	6	7
Andhra Pradesh	2.8	4.3	1.5	(-)0.3	(-)1.2	(-)0.9
Assam (including Meghalaya)	1.3	0.7	(-)0.5	1.5	1.8	0.2
Bihar	0.2	3.3	3.1	(-)0.2	(-)1.3	(-)1.1
Gujerat	1.1	5.6	4.4	(-)1.9	4.1	6.1
Haryana	6.8*	8.7*	1.7*	6.5	9.2	2.6
Himachal Pradesh	0.3+	3.7+	3.4+	0.5	2.7	2.1
Kerala	0.5	3.7	3.2	1.5	2.1	0.6
Madhya Pradesh	1.2	2.0	0.8	0.1	0.7	0.6
Maharastra	1.6	3.0	1.3	(-)0.2	2.3	2.4
Mysore	1.8	4.8	2.9	(-)0.2	1.8	2.0
Orissa	1.1	2.6	1.5	0.9	(-)0.1	(-)1.0
Punjab	6.8*	8.7*	1.7*	5.2	11.4	5.9
Tamil Nadu	2.8	4.9	2.0	0.4	4.7	4.3
Uttar Pradesh	1.8	4.2	2.4	0.4	1.9	1.6
West Bengal	0.1	1.4	1.2	1.0	1.0	0.0
All-India	1.5	3.2	1.7	0.4	1.3	0.9

Source: Saran,R. 'High-Yielding Varieties Cultivation - Some Economic Aspects' Agricultural Situation in India, XXVII, 5, Aug. 1972, p 325.

Note: * Figures for this period relate to Punjab before bifurcation into the states of Punjab and Haryana

\+ Relates to Himachal Pradesh as it existed before 1.11.1966

APPENDIX TABLE II

Relative Share of States in the Area under Rice, Production of Rice, Proportion of Total Area Irrigated and Proportion of Total Area under Higher-Yielding Varieties of Rice (percentages)

State	Area under Rice 1969-70	Production of Rice Average 1968-69 to 1970-71	Area Irrigated 1969-70	Area under HYVP 1970-71
1	2	3	4	5
Andhra Pradesh	9	11.2	93.7	16.0
Assam (including Meghalaya)	6	5.3	27.4	6.7
Bihar	15	11.2	34.8	6.6
Gujerat	1	1.0	27.2	9.8
Haryana	1	0.9	77.3	11.2
Himachal Pradesh	-	0.3	-	25.7
Kerala	2	3.2	53.9	30.2
Madhya Pradesh	12	8.0	15.4	6.4
Maharastra	4	3.6	23.2	15.9
Mysore	3	5.1	64.3	14.0
Orissa	12	10.9	20.1	4.0
Punjab	1	1.4	87.5	33.4
Tamil Nadu	7	11.2	89.9	67.7
Uttar Pradesh	12	8.3	19.4	14.9
West Bengal	14	15.3	28.2	11.0
All-India	100.00	100.00	37.7	14.9

Source: Column 2 Government of India, Central Statistical Office, Statistical Abstract of India, 1970, pp 58.

Column 3 Government of India, Ministry of Agriculture, Directorate of Economics & Statistics, Bulletin on Food Statistics, Twenty-second Issue, 1972, p 12.

Columns 4 & 5 Saran,R. op.cit., p 325.

Note: In Columns 2 & 3 the percentages do not add up to 100.00 because some States that produce rice have been omitted. The figure for Orissa in Column 2 refers to 1968-69.

APPENDIX TABLE III

Number of Improved Varieties of Rice in Different States of India, 1960-61

State	Total Number of Improved Varieties	Exotic Varieties Acclimatised	Total	Total Number under large-scale Cultivation
1	2	3	4	5
Assam	58	-	58	18
Andhra Pradesh	81	-	81	33
Bihar	46	-	46	19
Bombay (Maharashtra & Gujerat)	51	-	51	13
Kerala	55	-	55	14
Madhya Pradesh	36	-	36	14
Madras	82	4	86	27
Mysore	29	-	29	16
Orissa	56	-	56	19
Punjab	29	4	33	6
Uttar Pradesh	39	2	41	10
West Bengal	47	-	47	13
Jammu and Kashmir	2	11	13	3
All States	611	21	632	205

Source: Richharia, R.H. 'Rice Varieties in India, Varietal Improvements and Breeding Projects,' IF, Vol. XVII, 1, April 1967, p 7.

APPENDIX TABLE IV

Area under High-Yielding Varieties in Andhra Pradesh, Kharif 1967-68 to 1970-71 and Rabi 1967-68 to 1969-70

District	Kharif 1967-68	Kharif 1968-69	Kharif 1969-70	Kharif 1970-71	Rabi 1967-68	Rabi 1968-69	Rabi 1969-70
Srikakulam	7,483	14,733	50,862	90,088	7,272	6,839	16,778
Visakhapatnam	4,696	24,283	50,974	65,244	77	4,771	8,860
East Godavary	2,762	18,833	60,084	48,600	53,643	54,515	160,173
West Godavary	4,937	19,455	66,324	71,548	36,276	76,050	96,097
Krishna	5,022	22,297	38,131	31,200	14,549	69,298	109,989
Guntur	6,005	16,483	57,850	NA	14,107	17,517	94,330
Nellore	2,214	4,676	29,715	39,451	2,415	16,328	42,400
Chittore	15,117	23,027	36,209	64,185	17,099	19,594	50,486
Cuaadph	688	4,165	12,793	1,899	1,192	4,935	13,774
Kurnool	5,806	5,926	39,334	31,898	4,630	9,048	7,841
Anantapur	546	5,661	9,256	3,126	2,145	9,190	3,212
Hyderabad	1,392	2,091	7,415	8,511	1,117	403	4,269
Medak	22,481	1,857	3,419	11,775	1,481	3,939	3,736
Mahabubnagar	5,560	17,217	30,080	39,942	6,198	14,352	13,050
Warangal	5,232	17,729	29,690	31,686	9,337	7,342	26,789
Khammam	2,060	3,680	15,400	33,856	234	1,625	3,020
Nalgonda	872	2,513	33,860	30,125	464	4,835	24,288
Karimnagar	5,212	4,157	6,759	NA	3,707	3,558	11,414
Nizamabad	29,427	19,349	14,534	14,014	4,011	2,453	4,061
Adilabad	11,923	2,007	2,551	5,477	2,181	478	1,002
Total	139,435	230,139	595,240	622,625	182,135	327,467	695,569
Percentage to the paddy area	(2.11)	(3.57)	(9.25)	(9.67)	(9.28)	(16.68)	(35.44)

Source: Parthasarathy,G. & Prasad,D.S. 'Season-wise Progress of High-Yielding Varieties in Andhra Pradesh,' EPW, VI, 39, Sept. 1971, p A117

APPENDIX TABLE V

Distribution of Selected Cultivators, Operational Holdings per Cultivator, Percentage of Cultivators Growing IR-8, according to Size-class of Operational Holdings, West Godavary, Kharif & Rabi 1968-69.

	Number of Participants				
	Actual	Per cent	Per cent growing IR-8	Operational Holdings per Cultivator	Cultivated Area in Size Group as Per Cent of Total Area
1	2	3	4	5	6
<u>Kharif</u>					
Below 5.00	12	20	100	3.34	3.46
5.01 - 10.00	11	18	99	6.87	6.53
10.01 - 15.00	11	18	81	12.09	11.49
15.01 - 20.00	5	8	100	17.33	7.49
20.01 & Above	21	35	100	39.14	71.03
Total	60	100	93	19.29	100.00
<u>Rabi</u>					
Below 5.00	14	47	100	2.58	16.06
5.01 - 10.00	8	27	87	6.98	24.89
10.01 - 15.00	4	13	75	13.04	23.24
15.02 - 20.00	2	7	100	16.10	14.34
20.00 & Above	2	7	100	24.10	21.47
Total	30	100	93	7.48	100.00

Source: <u>Report for Kharif</u>, <u>op.cit.</u>, pp 4, 5 & 6
<u>Report for Rabi</u>, <u>op.cit.</u>, pp 5, 6 & 7

APPENDIX TABLE VI

Distribution of Selected Cultivators, Operational Holdings per Cultivator, Percentage of Cultivators growing IR-8, according to Size-class of Operational Holdings, East Godavary, Kharif & Rabi, 1968-69

	Number of Participants				
	Actual	Per cent	Per cent growing IR-8	Operational Holdings per Cultivator (acres)	Cultivated Area in Size Group as Per Cent of Total Area
1	2	3	4	5	6
Kharif					
Below 5.00	21	35	99	2.74	8.14
5.01 - 10.00	17	28	99	6.91	16.64
10.01 - 15.00	6	10	83	10.95	9.31
15.01 - 20.00	6	10	100	17.18	14.60
20.01 & Above	10	17	100	36.23	51.31
Total	60	100	95	11.75	100.00
Rabi					
Below 5.00	26	43	92	2.70	10.58
5.01 - 10.00	11	18	100	8.00	13.35
10.01 - 15.00	8	13	100	11.67	14.09
15.02 - 20.00	6	10	100	17.04	15.42
20.00 & Above	9	15	100	34.31	46.56
Total	60	100	97	11.05	100.00

Source: Report for Kharif, op.cit., pp 4, 5 & 6
Report for Rabi, op.cit., pp 5, 6 & 7

APPENDIX TABLE VII

Net Value Added and other Characteristics of Farms Cultivating HYV, West Godavary, 1968-69

Size-Class of Farms (acres)	Average Size of Operational Holdings (acres)	Area Irrigated %	Total Cash Expenditure Rs/a	Yield Q/a	Average Harvest Price Rs/Q	Gross Income Rs/a	Net Value Added Rs/a	Proportion of Cash Expenditure Financed by Borrowing %	Total Amount Borrowed per Acre Rs.	Hired Labour as Percentage of Total Labour	Area under Tenancy a[s] Percentag[e] of Total cultivate[d]
1	2	3	4	5	6	7	8	9	10	11	12
Kharif											
Below 5.00	3.34	100.00	406.62	21.53	54.09	1122.47	715.85	51	211.00	82	34
5.01-10.00	6.87	100.00	399.91	17.59	49.73	469.69	119.78	31	125.00	95	16
10.01-15.00	12.09	100.00	419.51	20.28	51.90	1243.66	824.15	11	49.15	98	17
15.01-20.00	17.33	100.00	303.29	20.98	50.86	1034.32	731.03	66	200.98	98	23
20.00 & Above	39.14	100.00	405.92	18.32	50.09	903.87	497.95	20	82.60	100	18
Rabi											
Below 5.00	2.58	100.00	477.46	20.77	53.26	1057.01	549.55	53	257.38	73	14
5.01-10.00	6.98	99.54	548.38	20.17	53.20	1020.10	471.72	55	304.86	87	21
10.00-15.00	13.04	94.77	561.54	18.79	53.20	1521.74	960.20	36	203.76	100	7
15.01-20.00	16.10	96.83	680.02	24.96	53.20	1008.67	328.65	10	69.04	100	8
20.00 & Above	24.10	100.00	626.63	24.68	53.20	1314.62	687.99	1	5.59	100	3

Source: All Columns except Column 12. Report for Kharif, op.cit., pp 6-9, 81, and Various Appendix Tables in Report.

Report for Rabi, op.cit., pp 7-9, 70, and Various Appendix Tables in Report.

Columns 12 Muthiah,C. 'The Green Revolution - Participation by Small and Large Farmers,' IJAE, XXVI, 1, Jan.-Mar. 1971, p 59

APPENDIX TABLE VIII

Net Value Added and other Characteristics of Farms Cultivating HYV, East Godavary, 1968-69

Size Class of Farms (acres)	Average Size of Operational Holdings (acres)	Area Irrigated %	Total Cash Expenditure Rs/a	Yield Q/a	Average Harvest Price Rs/Q	Gross Income Rs/a	Net Value Added Rs/a	Proportion of Cash Expenditure Financed by Borrowing %	Total Amount Borrowed per Acre Rs.	Hired Labour as Percentage of Total Labour	Area under Tenancy
1	2	3	4	5	6	7	8	9	10	11	12
Kharif											
Below 5.00	2.74	100.00	456.95	19.55	47.13	372.53	-84.42	58	265.71	88	34
5.01-10.00	6.91	100.00	410.40	20.91	48.20	711.86	301.46	47	193.35	96	16
10.01-15.00	10.95	100.00	380.91	13.50	45.74	509.04	128.13	49	188.43	98	17
15.01-20.00	17.18	100.00	343.23	16.14	45.98	627.64	284.41	28	78.34	98	23
20.00 & Above	36.23	100.00	374.16	18.16	47.18	468.81	94.65	32	118.56	100	18
Rabi											
Below 5.00	2.70	100.00	341.81	18.77	52.67	982.22	640.41	64	218.76	74	14
5.01-10.00	8.05	100.00	380.09	18.49	52.95	979.38	599.29	56	212.15	85	21
10.00-15.00	11.67	100.00	400.34	20.22	52.63	858.51	458.17	64	257.36	97	7
15.01-20.00	17.04	100.00	386.25	20.04	52.39	974.77	588.52	20	77.66	98	8
20.00 & Above	34.31	100.00	484.64	22.13	52.77	899.15	414.51	30	143.06	74	3

Source: All Columns except Column 12. Report for Kharif, op.cit., pp 6, 8, 88 & Various Appendix Tables in Report.
Report for Rabi, op.cit., pp 8, 9, 71 & Various Appendix Tables in Report.

Column 12 - Refer Appendix Tables VII

APPENDIX TABLE IX

Net Value Added and Other Characteristics of Farms Cultivating Traditional Varieties

West Godavary, 1968-69

Size Class of Farm (acres)	Average Size of Operational Holdings (acres)	Area Irrigated %	Total Cash Expenditure Rs/a	Yield Q/a	Average Harvest Price Rs/Q	Gross Income Rs/a	Net Value Added Rs/a	Proportion of Cash Expenditure Financed by Borrowing	Total Amount Borrowed per Acre Rs.	Hired Labour as Percentage of Total Labour
1	2	3	4	5	6	7	8	9	10	11
<u>Kharif</u>										
Below 5.00	3.34	100.00	253.14	28.82	57.19	1648.29	1395.15	58	149.13	89
5.01-10.00	6.87	100.00	224.35	17.29	52.02	899.89	675.54	23	53.55	96
10.01-15.00	12.09	100.00	235.53	5.78	51.87	299.84	64.31	16	39.37	100
15.01-20.00	17.33	100.00	241.48	6.09	57.99	353.21	111.73	1	2.44	98
20.00 & Above	39.14	100.00	226.94	0.85	56.52	48.45	-178.49	20	46.11	100
<u>Rabi</u>										
Below 5.00	2.58	100.00	366.97	441.91	66.50	29387.12	29020.15	87	321.71	73
5.01-10.00	6.98	99.54	431.68	73.58	59.85	4404.08	3973.40	51	222.08	91
10.01-15.00	13.04	94.77	452.65	20.50	59.85	1227.24	774.59	38	174.04	100
15.01-20.00	16.10	96.83	449.84	31.64	66.50	2104.25	1654.41	56	254.13	93
20.00 & Above	24.10	100.00	458.54	36.53	66.50	2429.80	1971.26	9	43.96	100

Source: <u>Report for Kharif</u>, <u>op.cit.</u>, pp 7, 9, 81 & Various Appendix Tables in Report.

<u>Report for Rabi</u>, <u>op.cit.</u>, pp 7, 9, 70 & Various Appendix Tables in Report.

APPENDIX TABLE X

Net Value Added and Other Characteristics of Farms Cultivating Traditional Varieties

East Godavary, 1968-69

Size Class of Farm (acres)	Average Size of Operational Holdings (acres)	Area Irrigated %	Total Cash Expenditure Rs/a	Yield Q/a	Average Harvest Price Rs/Q	Gross Income Rs/a	Net V Value Added Rs/a	Proportion of Cash Expenditure Financed by Borrowing	Total Amount Borrowed per Acre Rs.	Hired Labour as percentage of Total Labour
1	2	3	4	5	6	7	8	9	10	11
Kharif										
Below 5.00	2.74	100.00	139.86	62.93	55.86	3740.96	3601.10	33	47.55	82
5.01-10.00	6.91	100.00	156.44	17.12	51.87	888.28	731.84	18	28.29	95
10.01-15.00	10.95	100.00	144.37	27.54	55.86	1538.78	1394.41	89	129.09	100
15.01-20.00	17.18	100.00	137.40	15.24	52.53	800.81	663.41	6	8.47	97
20.00 & Above	36.23	100.00	132.69	13.26	54.53	723.12	590.43	8	11.85	100
Rabi										
Below 5.00	2.70	100.00	296.62	90.20	59.85	5399.05	5303.43	60	179.56	75
5.01-10.00	8.05	100.00	394.35	14.81	58.75	870.15	475.80	31	125.62	88
10.01-15.00	11.67	100.00	321.05	30.63	58.75	1800.00	1478.95	59	191.56	97
15.01-20.00	17.04	100.00	276.54	32.98	55.86	1842.58	1566.04	7	21.76	98
20.00 & Above	34.31	100.00	253.06	32.81	66.50	2182.03	1928.97	17	43.31	95

Source: Report for Kharif, op.cit., pp 7, 9, 88 & Various Appendix Tables. in Report.

Report for Rabi, op.cit., pp 9, 10, 71 & Various Appendix Tables. in Report.

APPENDIX TABLE XI

Cash Expenditure per Acre (Rs) in the Cultivation of Higher-Yielding Varieties, West Godavary and East Godavary, 1968-69

Farm Size (acres)	Seeds	Farm Yard Manure	Fertilisers	Pesticides	Hired Human Labour	Hired Bullock Labour	Irrigation	Total
1	2	3	4	5	6	7	8	9
Kharif				West Godavary				
Below 5.00	10.01	1.59	122.53	6.84	232.32	9.10	24.23	406.62
5.01 - 10.00	7.70	4.88	108.98	1.69	249.92	2.51	24.23	399.91
10.01 - 15.00	10.01	-	115.14	1.59	264.00	4.54	24.23	419.51
15.01 - 20.00	2.31	-	95.27	2.98	278.00	-	24.23	303.29
20.01 -	10.78	-	146.57	2.58	221.76	-	24.23	405.92
Rabi								
Below 5.00	16.39	4.17	190.57	17.52	216.89	7.04	24.88	477.46
5.01 - 10.00	13.49	10.75	205.60	34.31	249.98	9.37	24.88	548.38
10.01 - 15.00	16.69	-	229.50	-	290.47	-	24.88	561.54
15.01 - 20.00	18.96	13.36	263.00	-	259.82	-	24.88	680.02
20.01 -	4.81	-	321.35	-	275.59	-	24.88	626.63

APPENDIX TABLE XI (continued)

Farm Size (acres)	Seeds	Farm Yard Manure	Fertilisers	Pesticides	Hired Human Labour	Hired Bullock Labour	Irrigation	Total
1	2	3	4	5	6	7	8	9
Kharif				East Godavary				
Below 5.00	12.89	18.49	181.50	7.18	187.52	10.26	39.11	456.95
5.01 - 10.00	14.46	5.50	165.49	6.96	175.80	3.08	39.11	410.40
10.01 - 15.00	10.18	-	174.65	4.61	152.36	-	39.11	380.91
15.01 - 20.00	9.30	2.77	147.25	1.23	143.57	-	39.11	343.23
20.01 -	3.84	3.94	142.15	8.29	175.80	1.03	39.11	374.16
Rabi								
Below 5.00	11.33	3.69	164.29	9.96	116.28	1.15	35.11	341.81
5.01 - 10.00	8.18	3.94	193.30	8.16	131.40	-	35.11	380.09
10.01 - 15.00	3.65	-	183.51	14.43	163.64	-	35.11	400.34
15.01 - 20.00	5.63	-	177.49	6.51	161.51	-	35.11	386.25
20.01 -	7.29	-	246.04	12.19	184.01	-	35.11	484.64

Source: Report for Kharif, op.cit., pp 48, 49, 53, 54, Appendix Tables I - VI, XI, XIV, XXXIV, XXXV in Report.

Report for Rabi, op.cit., pp 49, 54, 55, Appendix Tables I -VI, XI - XIV, XXVIII, XXIX in Report.

APPENDIX TABLE XII

Cash Expenditure per Acre (Rs) in the Cultivation of Traditional Varieties, West Godavary and East Godavary, 1968-69.

Farm Size (acres)	Seeds	Farm Yard Manure	Fertilisers	Pesticides	Hired Human Labour	Hired Bullock Labour	Irrigation	Total
1	2	3	4	5	6	7	8	9
Kharif				West Godavary				
Below 5.00	-	8.43	20.67	0.85	203.00	4.68	15.51	253.14
5.01 - 10.00	5.25	3.84	16.22	0.87	178.50	4.16	15.51	224.35
10.01 - 15.00	3.00	4.68	15.96	0.72	192.50	3.64	15.51	235.53
15.01 - 20.00	4.50	-	13.25	3.10	204.60	0.52	15.51	241.48
20.01 -	0.75	1.42	19.74	-	189.00	0.52	15.51	226.94
Rabi								
Below 5.00	18.75	-	142.65	3.75	169.78	-	32.04	366.97
5.01 - 10.00	20.47	-	141.53	1.81	235.27	0.56	32.04	431.68
10.01 - 15.00	15.11	-	156.47	-	249.03	-	32.04	452.65
15.01 - 20.00	15.21	-	151.77	-	250.82	-	32.04	449.84
20.01 -	12.82	-	187.48	-	237.20	-	32.04	458.54

APPENDIX TABLE XII (continued)

Farm Size (acres)	Seeds	Farm Yard Manure	Fertilisers	Pesticides	Hired Human Labour	Hired Bullock Labour	Irrigation	Total
1	2	3	4	5	6	7	8	9
Kharif				East Godavary				
Below 5.00	-	1.27	23.03	1.58	95.16	3.15	15.67	139.86
5.01 - 10.00	-	2.05	21.44	-	112.24	5.04	15.67	156.44
10.01 - 15.00	-	-	18.27	-	109.80	0.63	15.67	144.37
15.01 - 20.00	-	6.76	17.92	-	95.16	1.89	15.67	137.40
20.01 -	-	1.41	18.25	-	107.36	-	15.67	132.69
Rabi								
Below 5.00	10.17	-	118.31	4.24	117.07	1.29	45.54	296.62
5.01 - 10.00	3.08	1.28	114.49	4.43	111.57	-	45.54	394.35
10.01 - 15.00	4.82	-	125.67	5.54	139.48	-	45.54	321.05
15.01 - 20.00	0.92	-	100.58	-	129.50	-	45.54	276.54
20.01 -	4.47	-	114.10	0.42	129.53	-	45.54	253.06

Source: Report for Kharif, op.cit., p 48. Appendix Tables I - IV, VII, VIII, XII, XV
Report for Rabi, op.cit., pp 6 & 9. Appendix Tables I - IV, VII, VIII, XI - XIII, XXVIII, XXIX

APPENDIX TABLE XIII

Production, Imports and Consumption of Fertiliser, (N P & K)

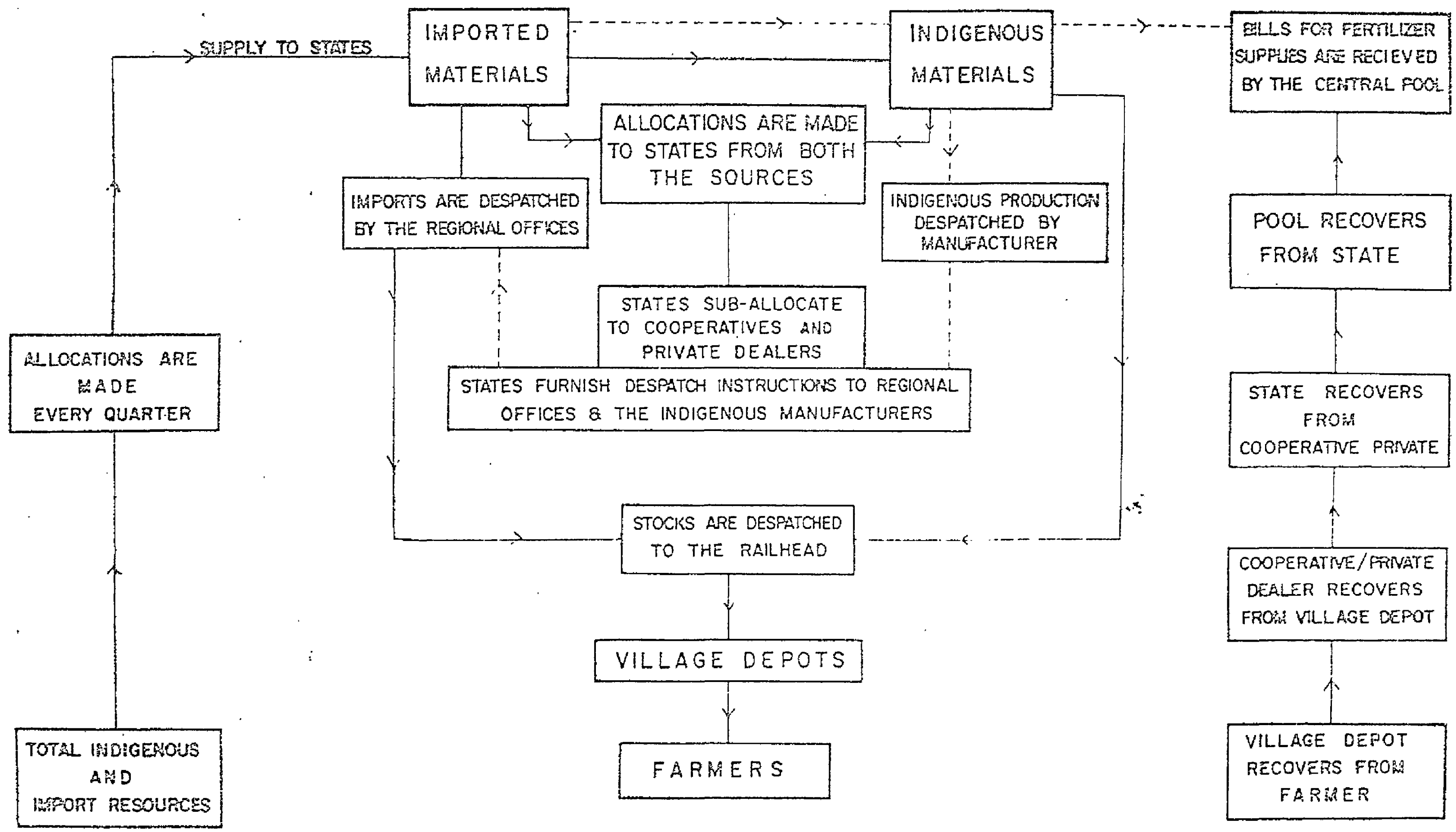
Thousand Tons

Year	Production					Consumption					Imports				
	N	P	K	Total	% change	N	P	K	Total	% change	N	P	K	Total	% change
1964-65	240	131	..	371	..	555	149	69	773	..	215	12	57	284	..
1965-66	233	111	..	344	7.3	575	132	77	784	+1.4	310	62	94	466	+64.1
1966-67	308	145	..	453	+31.7	738	249	114	1101	+40.4	630	150	143	923	+98.1
1967-68	367	194	..	561	+23.8	1035	335	170	1540	+39.9	868	349	279	1496	+62.1
1968-69	543	210	..	753	+34.2	1298	382	170	1850	+20.1	847	138	200	1185	-20.8
1969-70	716	222	14	952	+26.2	1244	315	137	1696	-8.35	667	94	164	925	-21.9

Source: Government of India, Economics and Statistics Division, Ministry of Petroleum & Chemicals, Mines & Metals, Indian Petroleum and Chemicals Statistics, 1969, p 79.

CHART I

FLOW CHART SHOWING THE DISTRIBUTION OF FERTILISERS IN INDIA



Source: Government of India, Ministry of Food and Agriculture, (Ministry of Agriculture), Report of the Committee on Fertilisers, New Delhi, 1965, p 52.

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